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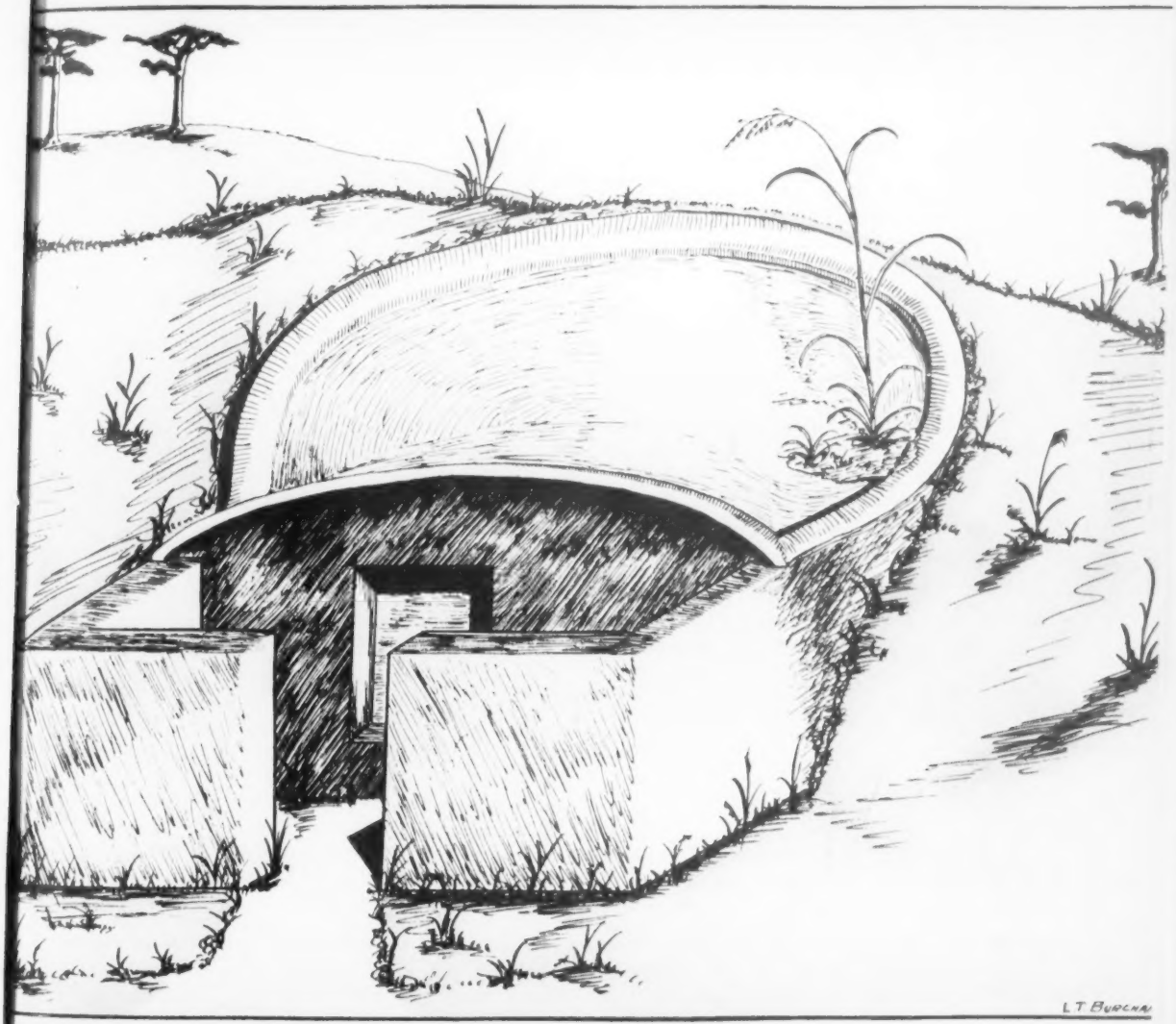

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See *A "Grass-Counter" in the Pacific*, page 21

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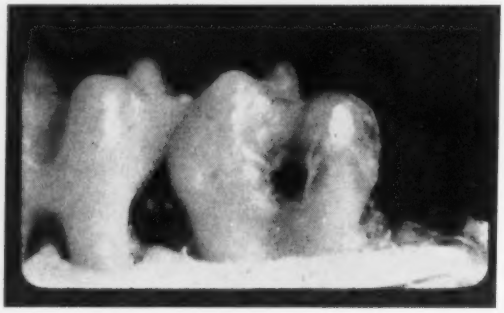

FIG. 3C. Penetrating Caries of Hamster Third Molars. Note the evidence of dissolution beneath the protecting enamel shell.

DENTAL CARIES AND FLUORINE

Tooth decay is one of the most prevalent diseases of civilized man and of great importance from the standpoint of both the individual and public health. Statistics relative to dental defects among the millions of young men who served recently in our armed forces are startling. They bear out the general opinion of the dental profession that the yearly increment among American children of teeth requiring attention is greater than all dentists in this country could repair.

The Association's previous symposium, FLUORINE AND DENTAL CARIES, published in 1942, covered the early history of the early relation between fluorine and dental caries particularly in this country. This new symposium includes determinations of the differences in the chemical composition of teeth subject to dental caries and of those which have been immune to dental caries. It also reviews investigations of the way in which fluorine inhibits dental caries. Reports from the British Isles, India, and South Africa, as well as the United States are presented

The many investigations reported in this volume bear also upon the broader and very important subject of trace elements in nutrition. These researches in the field of dentistry are, therefore, not isolated investigations relating to dental health alone, but bear also on the profound problems of cell metabolism. They illustrate and emphasize again the numerous interrelations among the many fields of science, and thus make all of science more interesting and of greater value.

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THE SCIENTIFIC MONTHLY

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THE NUTRITIONAL SIGNIFICANCE OF MILK WITH SPECIAL REFERENCE TO MILK SUGAR

By SAMUEL BRODY and DULAL PADA SADHU

Department of Dairy Husbandry, University of Missouri

Thou shalt have milk for thy food, for the food of thy household, and for the food of thy maidens.—King Solomon.

THE prohibition against producing patent and related refined flours (100 lbs. wheat yielding from 58 to 72 lbs. flour) in favor of 80 percent flour (100 lbs. wheat yielding 80 lbs. flour) brings home the fact that famine is really stalking the earth and that food is scarce even in this rich country. Under conditions of food scarcity the more efficiently produced foods tend to replace the less efficiently produced foods. There thus develops, often with the aid of religious or ideological sanctions, a change in dietary patterns and habits. What is the status of milk from this viewpoint of efficient production, utilization, and displacement of other foods? Will the trend be towards relatively greater or lesser consumption of milk and its products?

One factor of overwhelming importance in the over-all economy of milk production is the possession by dairy cattle of a huge (30- to 40-gallon capacity) fermentation chamber, the rumen (Fig. 1). All swallowed food and water passes into this chamber, where it is warmed, agitated, and fermented under most ideal conditions. The rumen microorganisms, like some plants in the field, synthesize proteins from such simple nitrogenous compounds as urea, asparagin, succinamide, nitrates, nitrites, and ammonium bicarbonate. They also synthesize B-complex vitamins. These organisms also produce various organic acids, such as acidic, lactic, pyruvic, and such short-chain fatty acids as are found in butterfat. Cattle, moreover, consume and digest, with the aid of their rumen storage and fermentation facilities, fabulous quantities of roughage which such species as

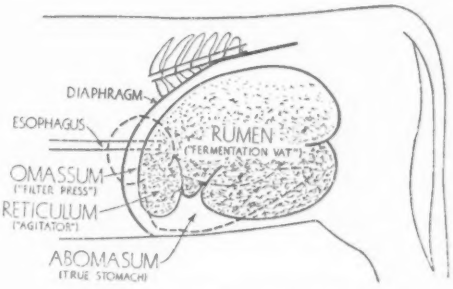

FIG. 1. DIGESTION IN CATTLE

THE MICROBIOLOGICAL SYNTHESIS OF AMINO ACIDS AND B VITAMINS IN THE RUMEN OF CATTLE MAKES THIS SPECIES WHOLLY INDEPENDENT OF DIETARY B-COMPLEX VITAMINS AND PARTLY INDEPENDENT OF DIETARY AMINO ACIDS.

pigs, chickens, and man cannot consume or digest. The milk nutrients are thus, in part, obtained in the nature of a windfall, from materials virtually useless for food of man and such simple-stomached species of farm animals as pigs and chickens.

A second factor in the economy of milk production is that it is an inherently efficient process. The energetic efficiency of milk production in superior dairy cows is

about 35 percent; 35 percent of the digested nutrient energy is converted into milk. The energetic efficiency of milk production is about twice as high as for egg production in comparably producing hens, and several times as high as for beef production. Pork production is more efficient than beef production, but pigs compete with man for grain and vitamins, which cows do only in part. The good dairy cow is the most efficient converter and creator (by way of the rumen microorganisms) of food of animal origin for man, and, unlike some cash plant crops, the grazing cow is a preserver of soil fertility.

The dairyman thus appears to be engaged in the most efficient food-producing enterprise, and milk as food is not likely to be replaced by other foods of animal origin. On the contrary, the relative consumption of milk in various forms is likely to increase with the passage of time because of the nutritional economy of milk production and because of the effect on soil fertility and national stability of the dairy enterprise.

THE broad significance of milk as a food may be considered from several viewpoints, such as its evolutionary significance, its physical condition, chemical composition, and nutritional value. Then, too, milk is unique in containing casein, short-chain fatty acids, and milk sugar not found elsewhere.

Milk is, in fact, the only substance developed in the course of evolution to serve as the exclusive food in the most critical period of postnatal mammalian life. True, milk is not suitable as an *only* food for adults, mostly because it is low in iron, copper, and manganese, substances normally supplied by the liver of young mammals. Many generations of animals have, however, been reared on exclusive milk diets supplemented with these minerals.[1] It is amazing that some 8,000 different species (about half extinct), ranging from reptile-like monotremes up through moles, mice, monkeys, and finally to man, should have developed this special food for their young, and that all milks should contain, although in different proportions, identical or closely similar milk constituents.

Since milk was evolved for infants, toothless and delicate of lining, it is not surprising that it has a fluid, bland form. Milk is a fluid, despite the fact that it has more solid nutrients per unit weight than many solid foods. For instance, whereas the solid content of fresh milk is 13 percent, that of turnips is 9 percent, tomatoes 6 percent, lettuce 5 percent. Milk, of course, coagulates into a solid—a light, fluffy curd—on reaching the stomach. These characteristics of milk are apparently evolutionary adaptations to the needs of the young. But these characteristics, together with the high buffer properties of milk, combine to make it also the most indispensable single food for the invalid—especially sufferers from delicate or injured stomach linings, such as ulcer. These properties also make it an excellent supplement to all diets.

As to the known chemical composition of milk, it is customary to present it in tabular form with, perhaps, a comparison of the content in a quart of milk (the optimal intake per day for an average person) with some dietary standard, such as the one recommended by the National Research Council. (Table 1.) This table of the chemical composition of milk does not, however, do justice to its nutritional significance; the nutritional value of a food cannot always be inferred from its chemical composition.

For instance, the recommended nicotinic acid for an average man is 18 mg. a day. As a quart of milk contains but 1 mg., it would be logical to conclude that one would have to consume 18 quarts of milk per day to supply the needed 18 mg. of nicotinic acid. This is not the case because milk is not only an excellent food for man but also for the microorganisms that synthesize

nicotinic acid in his intestine, and these organisms probably supply adequate nicotinic acid. The result is that a milk diet, although very poor in nicotinic acid, supplies abundant nicotinic acid, probably by stimulating the intestinal organisms to synthesize it (see reference *i*, Table 1). This holds to variable degrees for other water-soluble vitamins. Milk thus has a higher *nutritionally-effective* B-vitamin value than its chemical composition indicates.

It may be similarly shown that milk has

TABLE 1

NUTRIENT[a] LEVELS IN MILK WITH COMPARISON OF THE NATIONAL RESEARCH COUNCIL'S RECOMMENDATION

Nutrient	Amount in one quart[b] cow's milk	N.R.C. daily standard[c]	Portion of standard need supplied by one qt. cow's milk	Amount in one quart woman's milk
Protein, gm.	35	70	$\frac{1}{2}$	13
Fat, gm.	39			35
Sugar, gm.	49			75
Calories	700	3000	$\frac{1}{4}$	680
Ash, gm.	7.0			2.0
Calcium, gm.	1.2	0.8	$1\frac{1}{2}$	0.34
Phosphorus	1.0	1.2	$\frac{5}{6}$	0.15
Iron, mg.	1.0	12	$\frac{1}{12}$	2.0
Copper, mg.	0.1	1.0	$\frac{1}{10}$	0.6
Vitamin A, I.U.[d]	1800 ±50%	5000	$\frac{2}{5}$	2400
Vitamin D, I.U.[e]	20 (5 to 40)	400 (?)	(?)	4 to 100
Vitamin C, mg.[f]	20	75	$\frac{1}{4}$	50
Thiamine, mg.[g]	0.4	1.8	$\frac{1}{4}$	0.14
Riboflavin, mg.[h]	2.0	2.7	$\frac{3}{4}$	0.35–0.42
Nicotinic acid, mg.[i]	0.8	18	$\frac{1}{18}$	1.8
Pantothenic acid, mg.	3.5			2.0
Pyridoxine, mg.	0.67			0.04
Choline, mg.	147			
Biotin, mcg.[j]	30			8
Inositol, mg.	180			330
Folic acid, mg.	50			450
Tolid solids, gm.	130			120
Water, gm.	870			880

[a] For detailed vitamin values of cow's milk see Lawrence, J. M., Herrington, B. L., Maynard, L. A. *Am. J. Dis. Child.*, **70,** 193, 1945; *J. Nut.*, **32,** 73, 1946; Kon, S. K. *Proc. Nut. Soc.* Cambridge, **2,** 149–157, 1944. For vitamin values of human milk, see Macy, I. G., *et al. Am. J. Dis. Child.*, **43,** 1062, 1932; and **70,** 135, 1945.

[b] One quart milk = 0.975 kg. = 2.15 lb. = 946.5 cc. 1 kg. milk = 1.025 quart.

[c] For a 70-kilogram (155-pound), moderately active man.

[d] Includes both vitamin A and carotene. Great seasonal variations occur, depending on the content in food. Cow's milk contains about 330 mcg. vitamin A and 300 mcg. carotene; human milk, 650 mcg. vitamin A and 250 mcg. carotene.

[e] Vitamin D varies with the amount of exposure of cows to light and, therefore, with season. Commercial "vitamin D milk" contains up to 400 I.U. per quart.

[f] Vitamin C in milk as drawn from udder. Much is destroyed by pasteurization and light. Raw milk upon reaching the city contains about 17 mg. reduced ascorbic acid per liter; pasteurized milk delivered to consumer, about 5 mg. per liter and, if exposed to light, virtually none.

[g] Thiamine values are uncertain as from 5 to 25 per cent is destroyed on pasteurization.

[h] Riboflavin in milk as drawn from udder. While stable to heat, it is very unstable to light—about half is destroyed on exposing milk bottle to light for several hours.

[i] The need for dietary nicotinic acid apparently varies with the nature of the diet, especially with the tryptophane content. See Krehl, W. A., *et al. J. Nut.* **31.** 85, 1946.

[j] One mcg. = 0.001 mg.

a higher *nutritionally-effective* protein value than its chemical composition indicates. This is because the proteins in milk, by supplying limiting amino acids, raise the biological value of inferior proteins consumed with the milk. For instance, the biological value of potato protein is 70 percent when eaten alone but 86 percent when eaten with milk; the biological value of white flour protein (in bread) is 50 percent when eaten alone and 75 percent when eaten with milk; the biological value of corn protein is almost doubled by consuming the corn with milk.

It will presently be shown that milk sugar acts as an antirachitic agent, an effect which could not be inferred from its chemical composition.

Similar statements might be made with regard to the supplementary and protective values of many other milk constituents.

MILK contains the four basic nutrient categories: vitamins, proteins, minerals, and fuel (fats and carbohydrates). These nutrients are found in all good natural foods, although in different proportions. It is intriguing, however, that milk sugar, or lactose, is found in milk alone. Milks from all species of mammals contain lactose, and no other natural food contains it. Lactation is apparently the only natural process in which lactose is formed. No other sugar is present in milk above trace levels.[2] The sugar in blood is glucose, and the mammary gland produces lactose mostly from glucose.

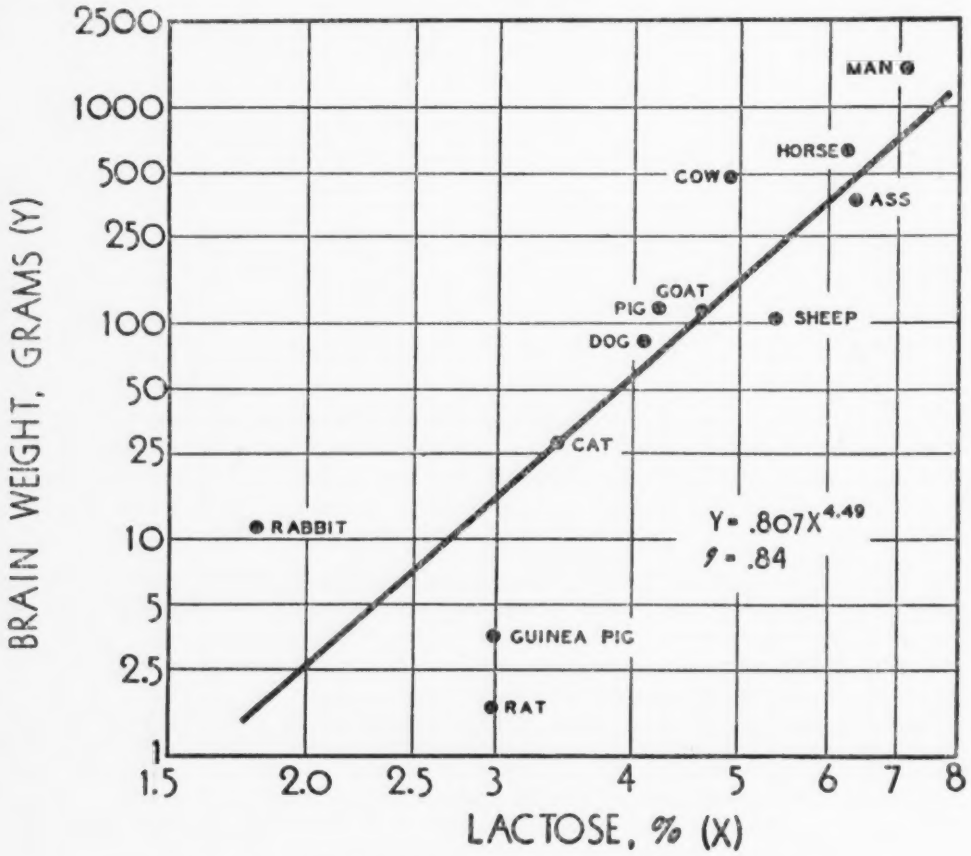

FIG. 2. LACTOSE CONTENT OF MILK VS. BRAIN WEIGHT

MAN HAS THE LARGEST BRAIN AND HUMAN MILK HAS THE HIGHEST LACTOSE PERCENTAGE. THE LACTOSE PERCENTAGE IN MILK OF DIFFERENT SPECIES TENDS TO VARY WITH THE BRAIN SIZE.

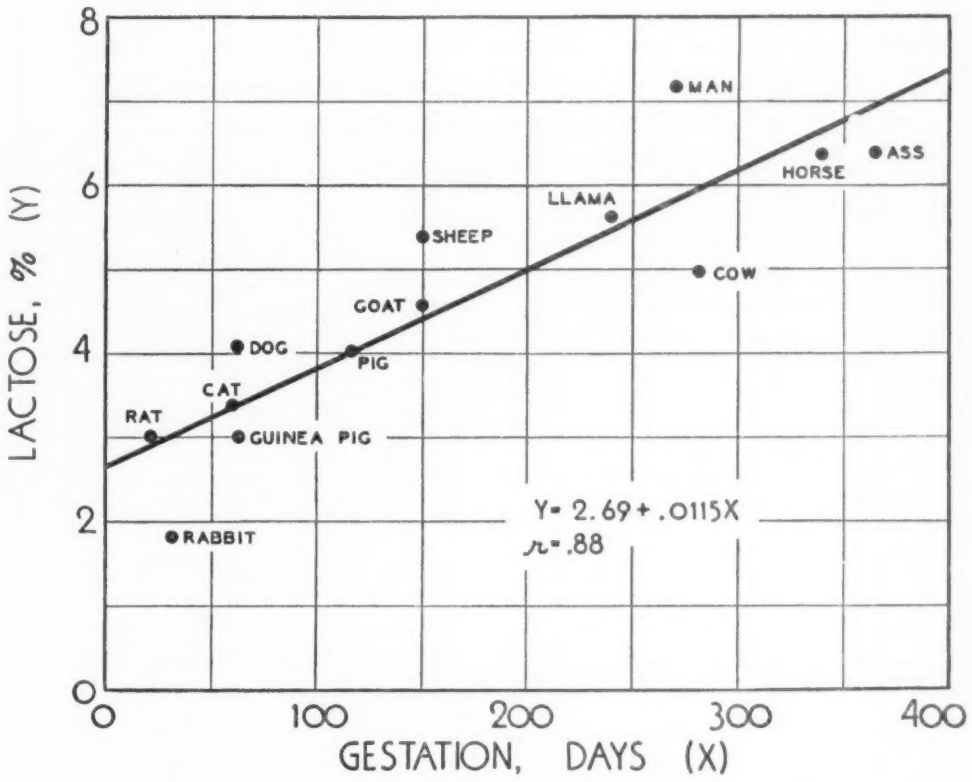

FIG. 3. LACTOSE CONTENT OF MILK VS. GESTATION PERIOD

THE LACTOSE PERCENTAGE IN MILK OF DIFFERENT SPECIES TENDS TO VARY WITH THE GESTATION PERIOD AND PHYSIOLOGIC AGE AT BIRTH.

It is also intriguing that of all species, human milk is richest in lactose. Lactose makes up over half (56 percent) of the dry matter in woman's milk, a little over a third (36 percent) in cow's milk, and only 6 percent in rabbit's milk. The sugar level in milk seems to vary *directly* with the weight of the adult brain (Fig. 2) and with the length of the gestation period (Fig. 3), and *inversely* with the fat and protein content of the milk (Figs. 4, 5).

Since the fuel value of lactose is the same as of glucose, from which it is derived, many believe that the nutritional value of milk sugar is no greater than that of cane sugar.[3] It does not, however, make sense to assume that (speaking figuratively) nature would go to the trouble of developing a special mechanism for producing lactose from glucose without serving some special function. Moreover, since mammals probably evolved from egg-laying forms, it would be simplest, from the evolutionary viewpoint, to produce milk of a composition similar to eggs, with the fuel in the form of fat; and the deviation from the principle of simplicity by evolving a special fuel, lactose, would seem to be significant. But what is that significance?

While lactose and sucrose have the same empirical formula, $C_{12}H_{22}O_{11}$, they differ in many respects. One molecule of sucrose yields on hydrolysis two molecules of glucose; but one molecule of lactose yields on hydrolysis one molecule of glucose and one of galactose. While glucose and galactose have the same empirical formula, $C_6H_{12}O_6$, they differ in spatial configuration.

The unique spatial configuration of lactose and of its constituent, galactose, gives it unique nutritional properties. For in-

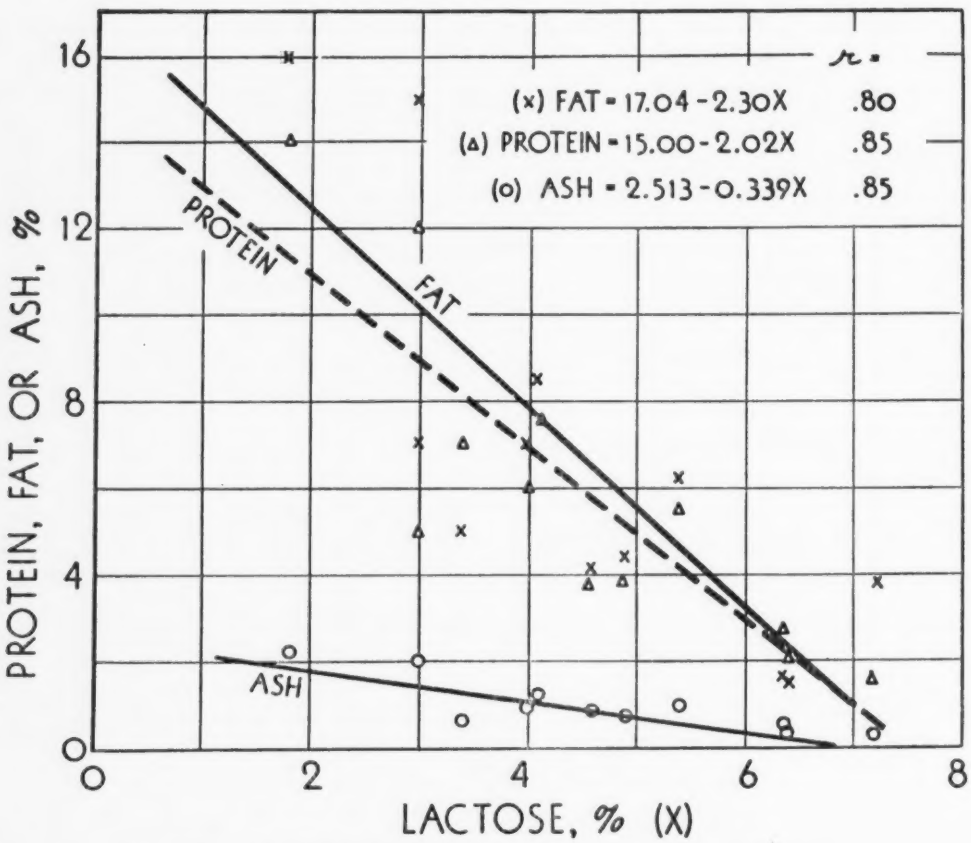

FIG. 4. LACTOSE VS. PROTEIN, FAT, AND ASH IN MILK

IT IS INTRIGUING THAT THE PERCENTAGES OF PROTEIN, FAT, AND ASH IN MILK OF DIFFERENT SPECIES SHOULD TEND TO VARY INVERSELY WITH THE PERCENTAGES OF LACTOSE.

stance, lactose is less soluble, less sweet, and more stable than sucrose. The lower sweetness of lactose (about one-sixth as sweet as sucrose) may be important in giving milk its bland taste and its acceptability as an exclusive diet. The lower solubility and greater stability of lactose enables it (unlike other sugars) to pass unchanged into the intestine. There the lactose nourishes acid-producing bacteria such as *B. acidophilus* and *B. bulgaricus*. The lactose is oxidized by these and related organisms to lactic acid.

And just as lactic acid keeps fermented milk (such as buttermilk) free from putrefaction and infection, so it also keeps the large intestine of man wholesome, free from scatological putrefaction. This is the basis of Metchnikoff's suggestion[4] for promoting "intestinal hygiene" and "prolongation of life" by greater consumption of milk.

The acid medium produced by lactic acid fermentation, moreover, facilitates the absorption or utilization of dietary calcium and phosphate; lactose thus acts as an antirachitic agent,[5] as does, for example, vitamin D, but, of course, by a different mechanism. Woman's milk is more antirachitic than cow's milk because it is much richer in lactose.

The relation of lactose to brain size (Fig. 2) may be explained by the fact that on hydrolysis lactose yields one molecule of galactose as well as one of glucose. The brain is rich in galactosides, that is, substances which contain galactose (as well as

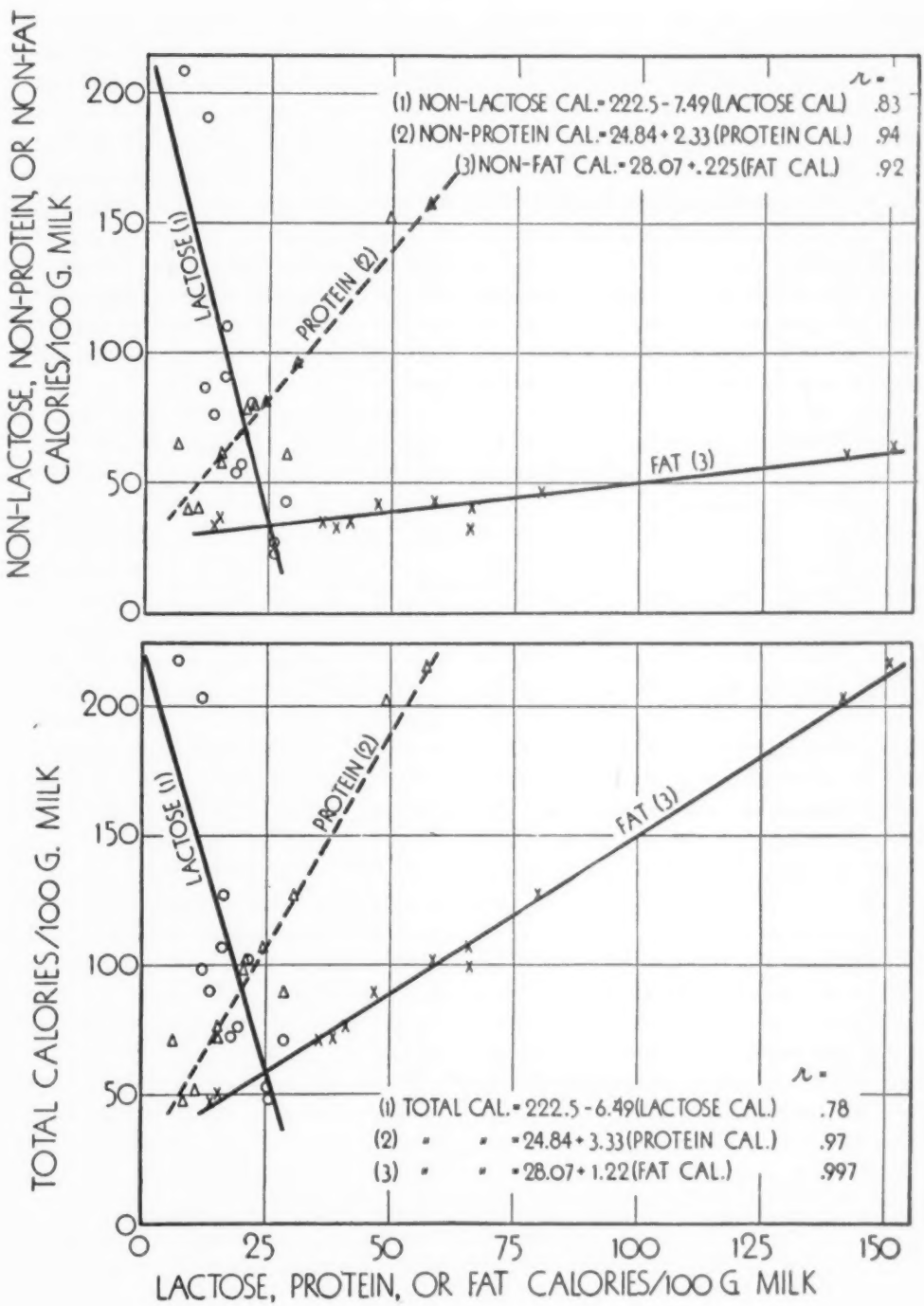
NON-LACTOSE, NON-PROTEIN, OR NON-FAT CALORIES/100 G. MILK
(1) NON-LACTOSE CAL. = 222.5 - 7.49 (LACTOSE CAL.) r = .83
(2) NON-PROTEIN CAL. = 24.84 + 2.33 (PROTEIN CAL.) .94
(3) NON-FAT CAL. = 28.07 + .225 (FAT CAL.) .92
LACTOSE (1)
PROTEIN (2)
FAT (3)
TOTAL CALORIES/100 G. MILK
(1) TOTAL CAL. = 222.5 - 6.49 (LACTOSE CAL.) .78
(2) " " = 24.84 + 3.33 (PROTEIN CAL.) .97
(3) " " = 28.07 + 1.22 (FAT CAL.) .997
LACTOSE, PROTEIN, OR FAT CALORIES/100 G MILK

FIG. 5. CALORIC RELATIONS AMONG COMPONENTS OF MILK

THE TOTAL MILK CALORIES (LOWER HALF) AS WELL AS THE NONLACTOSE, NONPROTEIN, AND NONFAT CALORIES IN MILK OF DIFFERENT SPECIES TEND TO VARY DIRECTLY WITH THE FAT AND PROTEIN CALORIES BUT INVERSELY WITH THE LACTOSE CALORIES IN THE MILKS.

fatty acids and nitrogenous substances). It is reasonable to assume that the larger the brain and the more rapid its early growth, the more galactose it needs for its galactosides and, therefore, the more lactose it needs in the diet; and that different species of mammals developed milks with lactose levels in proportion to their needs for galactose.

Glucose could, theoretically, be used in place of galactose for the production of brain and nerve tissue; practically, however, glucose may not be stable enough: it is too readily oxidized; indeed, glucose is apparently the only fuel normally oxidized by the brain. Galactose, a more stable sugar, was therefore presumably evolved. The consumption of galactose in the form of lactose thus increases the stability of the brain and nervous system above what it would be if glucose were the only available sugar. The adult may be able to synthesize the galactose to supply the normal metabolic needs of the nervous system, but the infant may not be able to synthesize the lactose at a sufficiently rapid rate during early rapid growth and development. But even the adult's nervous system may, perhaps, benefit, perhaps maintain higher stability, by consuming lactose (in the form of milk).

There is no experimental evidence for the suggestion that lactose may serve as a "stabilizer" for the nervous system, but it is not unreasonable. It is known that the convulsions following parathyroidectomy may be prevented or stopped by a milk diet.[6] This effect is attributed to the calcium in the milk and to the antirachitic effect of the lactose, as previously explained. But it is also possible that the lactose itself may have a stabilizing effect on the nervous system by supplying it with the "building stone" galactose.

In addition to such galactosides as cerebrosides, the brain contains sphingomyelins similar to cerebrosides except that in place of the galactose group there is a choline-phosphate group. Choline is very important, often becoming a limiting factor in many metabolic processes, in addition to forming acetylcholine, and there is some evidence, based on the clinical syndromes of Gaucher's and of Newman-Pick's disease (absence of cerebrosides), that the galactose of milk sugar, which enters into the structure of cerebrosides, may "spare" the choline in the companion lipoid sphingomyelin. This might be a very important function of lactose—to act as a choline-sparer.

A great deal more could be said about the nutritional consequences of the greater stability of lactose, such as forming the relatively more stable "galactose glycogen,"[7] maintaining a more constant blood-sugar level,[8] serving as a prophylactic to ketosis.[9] It was said (not proved) that lactose-fed rats probably live longer than sucrose-fed rats,[10] and have more "living tissue" than glucose-fed rats,[11] and that the specific dynamic effect (a waste energy) of lactose is probably less than of glucose.[12]

The lactose differences in the milk of different species, aside from differences in brain size, may be associated with difference in choline need. For instance, on stimulating the nerves of the sweat glands, some species, such as man, produce acetylcholine while others, such as the horse, produce adrenaline. The choline, and therefore lactose, requirements would be different in the two species.

Finally, it appears that there is a supplementary relation between lactose and butterfat. "It seems that nature has put lactose and milk fat together as an optimum combination for the young animal;" "lactose has an as yet unknown effect on intestinal conditions which is counteracted by butterfat but not by corn oil."[13] This problem is still under investigation, so that there is no agreement on these conclusions.[13, 14]

The present knowledge of the function of lactose seems clear on some points and

confused on others. It is clear that it has antirachitic effects; that it suppresses putrefaction in the intestine and promotes "intestinal hygiene;" that it may tend to prolong life; that it is involved in, or at least correlated with, the growth and development of the mammalian brain and somehow with the length of the gestation period and physiologic age at birth; that it is apparently involved in stabilizing some metabolic processes in the body; that milk sugar and milk fat may supplement each other in nutrition, as might be expected from their simultaneous evolution and from the organism theory. More knowledge is, however, needed to enable one to speak with greater assurance on this fascinating problem of the evolution of lactose and other constituents in the "most perfect food," milk.

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THE PARALLEL ROLES OF PHYSICAL AND SOCIAL SCIENCE

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IN THESE times when the values of science are being actively considered and issues are raised as between the service of social and physical science, it is appropriate to seek some perspective on the work which is being done. If we are to contribute to, rather than delay, the "trend toward system and unity in the scientific enterprise as a whole" we cannot afford to magnify distinguishing differences. We must look for some general purpose in the joint endeavor of scientists. Strange symbols and esoteric details often keep one area of science from becoming familiar to workers in another area. Can we not find common ground by overlooking technicalities and turning to larger aspects?

The effort to see social science in perspective is made difficult by the fact that we are all so close to it. And, again, the study of man and his relations, pursued in the manner of science rather than in the manner of individual judgment and ready prescription, has not been under way sufficiently long for its approach to prevail widely. There is a strong tendency to view the entire field in personal, commonsense terms. One is likely to ask, "What is individual behavior more than volition, and what are social problems more than differences of interest? Is not the heart of the matter that of getting people to be less selfish in their living and more cosmopolitan in their outlook?" Perhaps; but does such a general conception direct attention to the possibilities of scientific insight? Does it provide suitable guides for scientific effort? Familiarity with outward aspects does not guarantee understanding of inward relations.

In parallel fashion one might ask, "What is physics more than the study of the relationships and movements of units, large and small? Is not the heart of the problem that of getting things to move as we desire them to?" Possibly; but from a statement of this nature one might conclude that physics was given mainly to such commonplace matters as how to drive nails or knock croquet balls about. Simple conceptions do not encompass the horizons of scientific endeavor, nor do they establish its basic character. The sophistication of mature thought is not comprehended in sketchy verbalisms.

It is important to ask whether a particular conception of a field is conducive to the development of science on the level of basic principles or on the level of engineering applications. Is there some danger that we, as scientists, shall insist that physical science be thought of in terms of systematic abstractions and at the same time conceive of social science in terms of purely practical attempts? To do so is to contribute to the continued poverty of social understanding and to deny to social science the discharge of its main duty. For one does not approach an area solely in terms of immediate, practical considerations and come out with science. In all fields of understanding there is the necessity for a framework of theory as a basis for more concrete forms of application, and it is to the gradual development of this frame of thought that fundamental effort in any science must primarily be dedicated.

The development and testing of theory carry us beyond the level of everyday observation and interpretation. So long as one looks at society in terms of personal problems he will see only personal problems in society; when one views society with scientific interest he will observe in man's

behavior significant generalities. Basically, it is the social scientist's purpose to find in social phenomena those underlying uniformities which can be integrated into a thought structure that is capable of abstract manipulation and is reasonably accurate in predicting consequences. By virtue of these properties this science should be effective in affording man some control over the world of social events. It is the social scientist's conviction that by studying man and his behavior scientifically he will eventually be able to offer society not only a coherent system of ideas about man, but a consistent set of principles which can be utilized by man for his own betterment.

What problems will social science solve? Will it undertake to remake human nature? Will it stop wars? Purge society of crime? Eliminate poverty? For perspective we can turn to the field of physical science. Does man try to change the course of the planets? Does he counsel the seasons? Do his deliberations level the tides? The answer is that man does what he reasonably can. He adapts nature to his advantage where feasible and adapts his habits to nature where necessary. Thus he stores the rain in reservoirs, but builds houses and wears clothes to temper the effects of weather. He seeks to manage in part where he cannot command in full. Without serious thought of checking the continuous rise and fall of coastlines he dredges harbors and raises dikes. In the field of human relations we can expect man to do the same sorts of things he does in the field of physical relations. The social scientist cannot remake basic human traits, but he can modify and redirect them. He can aid man in making more satisfying and efficient adaptations and, as his scientific knowledge increases, he can develop new forms of control over social conditions and forces.

How, in practical terms, are such things to be done? For example, how will social science settle conflicts of interest from which so many social difficulties spring? Will science forsake its long tradition of impartiality and take sides? Will it make the strong stronger and the weak weaker? Will it prepare for one side lessons in the art of docile living while tendering to the other techniques of domination? The answer must be that immediate action is the province of the administrator and the practical worker, not of the researcher or the designer. The social scientist, in studying the forces of society, will take note of those which oppose each other, but he will not expect to build science by deciding disputes. He may participate in practical affairs as a form of personal service and as a matter of maintaining an orientation, but vocationally his are not the functions of the legislator, the administrator, the jurist, or the moralist. The world's work has many divisions with differing responsibilities. The scientist's service is real even if it be several steps removed.

In the physical field, man has learned to utilize much of science for his advantage. We may therefore turn to technology for further ideas on how to put knowledge to work. Physical science has not eliminated opposed forces either in equilibriums or in "opposite and equal reactions;" and we cannot expect to eradicate them, in either static or dynamic form, from the social scene. But through technical applications of science man does hope to deal with forces, whether physical or social, before they reach critical proportions, and his goal is to arrange conditions so that forces will expend themselves in contributing to the common good instead of wasting in useless heat or dissipating in wanton destruction. The purpose of science, practically, is to provide principles by which such ends can be achieved.

Applications of physical science have given us factories, railroads, airplanes, radios, mechanical refrigerators, and so on. These things are possible because means have been found for transforming

and channeling energy so that it behaves within limits which man expects and regards as desirable. Man builds machines which utilize force and carefully direct it. Thus the combustion in the cylinder of a gasoline motor does not wreck engine and operator because the energy is confined by adequate forces and masses opposed to it, and the force generated is largely directed toward the work to be done. Technology, rooted in principles of science, consists essentially in prearranging responding parts and inertial masses so that force will serve man's will.

The social scientist thinks of social machinery in the same fashion. For every phase of scientific knowledge and application in the physical field there is a counterpart in the realm of society. Social forces, no less than physical forces, have their methods of generation, their mediums of transmission, and their appropriate machinery for translation into effective results. Anyone who doubts the reality of social force must of necessity doubt the reality of war, and anyone inclined to question the actuality of social machinery must question the existence of government. The commonly observed conflicts of interest in the field of society are no different in their general outline from the contrary forces in the physical world or the universal competition in the biological world. The problem in any case is one of studying the kinds of machinery which are effective and efficient in transforming, conveying, and utilizing force.

The skeptical may insist, "Show me these social machines. Let me examine their parts. I must have concreteness." Does one ask to see shafts and pulleys in the universe? Does he question whether objects fall because he can see no lever to push them down? Are we to doubt that light and gravity traverse empty space because we know of no medium which conducts them? Social machines are common patterns wrought in the minds of men. They exist largely as conventions, sometimes written, more often not. They may be laws, they may be traditions, they may be newly accepted practices. In essence, they are attitudes, habits, and expectancies —mind sets which generate, guide, and limit action. But we need not be concerned here with substance. That is the province of the social scientist; the point of general interest is that conditions can be arranged in society so that force is channeled and regularized.

To avoid a world of chaos all of us want adequate social machinery, and we want competent administrators prepared to operate it. We want the aggregate energy of mankind to express itself within generally acceptable limits and be directed toward the accomplishment of ends which are both socially and individually beneficial. It is theoretically possible to design social machinery having various degrees of immediate efficiency—to waste different amounts of the social energy in "heat," "friction," and "lost motion." It is possible to set the design so that the tolerance limits for satisfactory results are very narrow, as in totalitarian states, or very broad, as in a democracy. It is possible through design to establish high or low factors of dependability, stability, or safety. In short, with increasing scientific knowledge and within the limits of compatible characteristics, any kind of social machinery that is desired can be arranged.

One may be tempted to ask, "Then why don't the social scientists design an ideal machine and stop all the inefficiency and turmoil in the social world?" One might as well ask, "Why don't the engineers in the automotive field give us a motor which obtains all the value of the fuel, loses no energy in wasted heat, has no internal load, does not get out of order, and will not be superseded by something better?" Our wishes must not mislead our judgment. We live in a practical world, a world of conflicting values and necessary

compromises, both social and physical. There is not now and never will be any perfect form of gasoline motor, or of social life. For that which is ideal in some respects is achieved by sacrifices elsewhere; and that which has been attained is soon thought ordinary, denying satisfaction for long. In the dreams of tomorrow the goals of today are forgotten. Knowledge advances, interests shift, desires expand. Under the impetus of changing conditions and perspectives designs also must change. Science knows no rest. Continued effort fashions constantly improved offerings, but never the ultimate.

With respect to getting his knowledge and insights incorporated into practice, the social scientist is in much the same position as the designing or consulting engineer. Neither one can set up what he regards as the most desirable model and then say, "Here is what the world should have; take it." Save for their professional writing both work at the bidding of others and within limits set by others. The scientist characteristically and almost necessarily looks at his problems in fairly narrow terms; society has found it practicable to set up other groups (administrators and legislators) to look at problems in broader terms and to interpret more widely the desires of people. So the designer of some phase of a new model of an automobile is told to work out his design within the limits of certain over-all specifications decided on by a planning board, most of whose members are not engineers at all. Likewise the social scientist who works out a new form of government, or perhaps a model city plan, will probably not find it of any use to do so unless he has been requested by an administrator or a policy-forming group to assist them, and unless they have laid down the general limits within which his study and recommendations are to fall. When engineers are members of policy-forming groups they have a better opportunity to advance their particular views; but the social engineer is not free to "run" society any more than a designing engineer "runs" an industry. Scientists are frequently disappointed; but beyond the beliefs and recommendations of specialists lie the judgments of the great body of people who, theoretically and practically, are the ones to be satisfied.

THERE are other parallels between physical and social science which should be noted. Perhaps the one of largest interest concerns the presumed normative character of social study. One not infrequently finds among his friends a tendency to think of the events of the world as falling into two classes, those which are in the domain of science and those which are covered by morals. There is a tendency further to identify physical things with science and social affairs with morals. Such an attitude grows out of man's long background of thinking about human action primarily from the moral point of view; he may not realize that behavior can also be looked at from many other frames of reference. Hence, even among some physical scientists, there is a strong belief that the chief character of social science is normative, that is, that it exists to determine what people *ought* to do. Much of what has just been said bears on the point: Society has given to groups other than physical and social scientists the function of interpreting its current wants and deciding what should be done. But the question as usually conceived goes deeper: Is there not something beyond immediate wants? Are there no fundamentals in man's existence? Does the social scientist not have anything more to offer society than machines? Can he give no advice as to the ends for which machines are to be used?

The first answer to these questions is, No. The fact that, as individuals, we recognize a strong need for definitive answers in the area of large purposes and ideals is not warrant for assuming that science is the

appropriate medium for providing those answers. We must always give heed to the fine line between science and philosophy. The first obligation of science is to view the world of things as they are. This view is normative only in the sense that it is descriptive. Social science is concerned with the same kind of aspects in the social world that physical science is in the physical world. One is not immediately any more moral than the other. The problems of weighing the findings of scientific work and weaving them, along with other considerations, into a suitable picture of the ends for which man should hope and the purposes for which he should live are the responsibility chiefly of philosophy and of religion.

But the second answer to the questions is a qualified Yes. Man's basic interest in the world does not stop with a description of statics; man seeks as well a description of natural processes, of changes which regularly follow certain patterns. The second obligation of science, therefore, is to deal with the world as a system of interactions—a world of cause and consequence. The mature scientist sees the static aspects of nature as but phases of a dynamic universe. Accordingly, the social scientist, in studying manifold social sequences, has the duty of studying those which involve various goals and various intermediate values. When man lives according to certain specified ideologies, what happens? Does he progress toward the goals he hoped for? What do different patterns of living lead to?

The social scientist does not seek to prescribe the ultimate; science finds no answers for basic teleology. That is an area for individual interpretation and group choice. But science can hope to identify those proximate ends which tend toward certain ultimate purposes, and it can in turn describe the general effect on society of holding various philosophies. Science has no traffic with notions of inherent rightness, but it has a basic interest in discovering what results follow the acceptance of particular orientations. To this end the social scientist will gather data over long periods of human experience and from the varied practices of widely dispersed societies. He will describe, analyze, and relate. Like the physical scientist, he will seek to sift the essential from the nonessential among the conditions which produce certain results. Without presumption to moral finality, his findings will give breadth and perspective to the thinking of philosophers and to the plans of statesmen.

As for those who may fear that the social scientist, after prolonged study, will decide how man should live, and dictate the ends he should accept for his existence, they may refer to the relation between science and philosophy or religion. Certainly physical science narrows the range within which man's reasoning is unrestricted; but does it not still leave large opportunity for man's yearning to go beyond scientific facts and build pictures which quicken his daily effort, strengthen his high resolve, and encourage his trust that in ethics there is something enduring? Social science will restrict and refine man's notions about what is good, but it will not take from man his right to think, to interpret, and to decide. Social science affords a mirror for man's behavior and a telescope for his judgment, but man's ultimate choice is his own. Society determines its course, with such counsel as it may take, through the instrumentality of the machinery it elects.

The reality of values cannot be doubted. There are ends for which each individual hopes and there are goals toward which he strives. Values relate his activities to these large ends. They are as real as the tropisms of biology or the "pulls" in any field of science. We may not understand why a tree grows vertically but we do not therefore ignore or deny the tendency. One might as well demand a science of physics without gravity, or a science of chemistry

without valence, as a science of man without values. They are part of the scheme of attractions which move mankind as planets and particles are moved. The full nature of the causes which make all things move—the nature of energy, of life, of psychological response—is perhaps as much a basic mystery in one field of science as another. Science studies what it finds means of studying. We must concede actualities whether or not we can resolve them.

But values are not absolute; they are not ultimate, they are instrumental. They are connecting links between statuses and purposes. They inhere in the relationships between properties and large designs, relating the means to the end. We may draw an analogy from the physical world by asking, What is the value of air? The respondent may point out that air is necessary to support life, though it does not guarantee life. It affords temperature moderation, else we should have the extreme heat and cold of the moon and all life would disappear. It carries water vapor, supporting the hydrologic cycle and permitting terrestrial life. It transmits sound. It supports aircraft but is an impediment to rockets. It turns windmills and sails ships; it produces storms and destroys. It is generally impure; it often contains smoke, sulfur dioxide, and noxious gases. It carries dusts, soot, bacteria, viruses, pollens, and fungi, giving rise to many ills. What is the value of air? Specific properties become utilities when related to purposes. Values, scientifically, are these utilities.

Given certain ends, the industrial engineer can say that certain materials and processes are necessary in order to achieve them. We hope that the social scientist or social engineer may be able to draw on his pure principles to render the same sort of service. He will be acquainted with the basic psychological needs of mankind—the essentials without which a society cannot be stable and maintain a long-time existence. He will know what values are called for in order that certain more distant ends espoused by a civilization may be approached. He will recognize that certain goals are incompatible with others. He should be able to outline what consequences may be expected when certain values are increased, reduced, or altered.

And, while pursuing these practical activities of helping society solve its problems, he will probably find opportunity to develop his basic science still further. Has not pure chemistry profited from research connected with the very practical problems of producing better electric lamps, or polyamides for manufacturing nylon?

Science arises wherever man turns his attention with intent to observe, describe, relate, and synthesize. In both physical and social science the fundamental object is the study of force—its generation, its behavior under the influence of various factors, its effective control through the arrangement of other adequate forces and masses, and ultimately its appropriate channeling so that it will serve ends chosen in advance by man. These ends then become a part of the cause-effect sequence which must be understood in designing and operating physical or social machinery. The social scientist may wish with the physical scientist that the affairs of man were conducted on a higher plane; but he takes human nature and human behavior as the physical scientist takes physical nature and physical behavior. It is their duty to study and describe and to offer their findings for the service of mankind. It is not ground for criticism, however, if either one works with the thought that his developing insights may eventually bear fruit in making a better world.

The advance of science lies along a broad avenue, theoretical on one side, practical on the other. We must honor workers who find their chief interest principally along one side or the other of this avenue. There must be theory; there must be applications.

What the ideal proportion is cannot be stated. Pure science must synthesize and provide an interpretation for the numerous practical studies; it must delve into areas which only the theorist immediately cares about; it must be the fountain from which many new applications become possible. But basic science is not the most common nor the most conspicuous form. The ratio of expenditures for applied research to expenditures for pure research is about six to one in this country, not counting war research. If social science seems at times to be characterized by nearness to practical problems, does it not find a stimulating precedent in physical science?

It is not fitting to close without pausing for recognition of the underlying motives of the true scientist. His work is so little understood that it deserves frequent appreciation. Behind and beyond all thoughtful modes of adaptation lies the scientific spirit. This spirit is not entirely separate from man's wants, for it dwells in man; but neither is it to be identified wholly with practical affairs, for it transcends the bounds of necessity and exceeds the stress of immediacy. It may be called man's curiosity at work; in truth it is more than that. It is the steady conquest by intellectual force of the mysteries of nature. It is the reconstruction in comprehensible terms of a universe which, in its original form, is largely incomprehensible. Science is man's most daring response to the challenge of the vast unknown. It is an expression of his willingness fearlessly to face truth. If in our several labors we have effected something of a division of effort, can it be said that research workers are less able to satisfy their deep desire to understand and appreciate nature when engaged in the study of man than when engaged in the study of masses?

A "GRASS-COUNTER" IN THE PACIFIC*

By L. T. BURCHAM

Captain, U. S. Marine Corps Reserve

THE following is a compilation from notes and letters written while on duty with the First Marine Division, Fleet Marine Force, in the Southwest and Western Pacific, with such additional remarks regarding place names, locations, and movements as the removal of wartime censorship regulations now permits. The writer was on military furlough from a position as Range Examiner with the U. S. Department of Interior.

Somewhere in New Zealand
November 15, 1942

Dear Miriam:

While en route to our overseas destination our conversations frequently turned to speculation on the nature of the terrain and vegetation in the country we would be visiting. Knowing that the climate of the region was of the Mediterranean type, I'd predicted that we'd find many of the familiar annual grasses and weeds which have been introduced into southern California and are so common and widespread in other regions. This suggestion was met with comments ranging from faint doubt to absolute disbelief.

The day after we reached port I had an opportunity to get ashore for a few hours. Sure enough, before we'd been on land ten minutes we passed a waste spot beside a warehouse where we saw bur clover (*Medicago hispida*), a rye grass (*Lolium* sp.), a brome grass (*Bromus* sp.), and the same species of chicory that was growing in the garden in front of our house when I left home. During the afternoon's walk, all within city limits, we observed 12 additional species of plants—aside from those cultivated in gardens—which would be familiar to almost anyone: These included 5 grasses, 2 shrubs, and 5 broadleaf herbs. They bear out my point that to one interested in plants and their distribution, familiar friends will be waiting whenever he steps ashore. These will help him to feel at home in strange places, and one will also be able to make new and delightful acquaintances.

So it is here—one sees a few familiar plants and many strange new ones. The general appearance of the vegetation is interesting, too; largely from the effect of the wind and topography upon it. We are in an area where steep mountains are fronted by a narrow, comparatively level coastal plain. The original vegetation, now largely cleared away, was forest, with small areas of grassy meadow in some of the canyon bottoms and on the windswept heights. There are, in this region, prevailing winds from the northwest quadrant which sweep in off the Tasman Sea and Cook Straits almost continuously and with great force; they carry quantities of fine sand particles, enough to affect the eyes. The apparent effect on tree vegetation is to "hedge" it— when traveling a trail that affords a view downward on the tops of trees and shrubs they appear similar to a close-cropped hedge or as though heavily browsed by livestock. Their leaves are nearly all thickly cutinized and leathery in texture.

Within, these forests have a tropical aspect. The canopy is quite dense; there is almost a complete absence of undergrowth and practically no litter under the trees. Epiphytes and mosses, lichens and lianas are plentiful, the lianas frequently entwining the trunk of some small tree so tightly as to deform it into a gnarled, spiraled, grotesque form. Ferns are so

*"Grass-counter" is a common appellation of range examiners throughout the Western states.

predominantly a part of this flora that the fern has been taken as the emblem of the Dominion; they are everywhere in evidence —sword fern, bracken, maidenhair, and the ancestral tree ferns.

To you—in the Northern Hemisphere where winter is just beginning—it will seem strange when I say it is early spring here. The flowering heads of the grasses are just starting to break out of their sheaths. In another week or so I should be able to start the collections that I've planned; so I shall have to get busy then and "make hay while the sun shines."

Guadalcanal
December 7, 1942

Dear Miriam:

This island is somewhat unique among the islands of the Southwest Pacific in that its northern half consists of a gently rolling coastal plain extending from the base of a high range of mountains to the sea, a feature that is not common in these parts where rugged topography is the rule. Natural grasslands occupy considerable portions of this coastal plain, with long fingers extending up into the foothills on the north and west slopes of the ridges. The species of both grasses and other plants are for the most part unfamiliar to me, but their characteristics are similar to many observed in other areas; it will be fascinating to delve more deeply into the relationships of the plants encountered here.

Goodenough Island
Territory of Papua
October 25, 1943

Dear Miriam:

After a ten months' sojourn in Australia we are again in the tropics. Their warmth is particularly ingratiating after the chill of a winter in southern latitudes. And again the abrupt transition from winter to summer has emphasized the verdure of the tropics.

Our camp is located in the margin of the rain forest, not far from the base of Mount Nimadao, a peak that towers more than 7,000 feet above us and has its summit wreathed in white clouds during much of the day.

The mature rain forest, such as that in which we are camped, is composed of a wide variety of trees, both hardwoods and softwoods, ranging up to 150 feet or more in height. I have noted 3 or 4 species of wild figs, several legumes, one tree whose fruits indicate it to be an ebony, and one that I believe belongs to the genus *Eucalyptus;* these are only a few of the almost innumerable kinds. Ordinarily there is little underbrush in the mature forest—small native clearings tend to cause a good deal of it, extending into the surrounding forest at every point where the sun is admitted. There is a considerable ground cover of ferns, mosses, broad-leaved herbs, and quite a few trailing plants of the legume and morning-glory families; the treetops are often intertwined with many lianas. I have noted no grasses growing in the forest proper but have seen a few small sedges. A number of grasses which apparently require part shade have been seen along the margins of the forest. The litter on the forest floor is very sparse, in places not entirely covering the ground; seldom more than an inch in depth, this is in vivid contrast to the relatively deep litter occurring under forests at home.

From this description you can correctly assume that my impression of the jungle is quite divergent from that portrayed by current stories from the Pacific islands which tell of the dank, steaming masses of tangled tropical vegetation growing in a perpetual ooze. Indeed, I find that the jungle is *not* a fearsome place.

Between our camp and the ocean stretches some 2 miles of savanna—tall tropical grasses varying from 3 to 6 feet tall, interspersed with occasional trees which are a light-barked, sparse-foliaged species of legume, invariably found associated with the grasses of these savannas. Elsewhere

Official U.S. Marine Corps Photo

MOUNT NIMADAO, GOODENOUGH ISLAND

ITS SUMMIT, TOWERING MORE THAN SEVEN THOUSAND FEET, IS USUALLY WREATHED IN WHITE CLOUDS.

appear considerable tracts of open grassland—the grass species being similar to those in the savannas—but the trees are absent. On this island some areas of grassland extend high up on the mountain slopes, to elevations of 3 or 4 thousand feet above sea level.

Since Goodenough Island has been scarcely touched by white men and was but thinly populated by native peoples prior to their advent, the natural vegetation has been very little disturbed. Collections should prove interesting as well as provide useful data on the distribution of plants occurring here.

Official U.S. Marine Corps Photo

ISLAND NATIVES

A DARK-SKINNED, FUZZY-HAIRED, SHORT-STATURED MELANESIAN PEOPLE ON GOODENOUGH ISLAND.

Goodenough Island
November 26, 1943

Dear Miriam:

My first collecting was done in the vicinity of a small native village located a short distance from our camp. For the most part the local inhabitants—a dark-skinned, short-statured, fuzzy-haired Melanesian people—were removed to a neighboring island when Allied military forces began to establish a base here. I prowled about their deserted houses. They are small, grass-thatched shacks, raised 4 to 5 feet above the ground to keep out dampness from the frequent rains. The floors are made from pieces of split bamboo or the outer layer of the trunk of a palm tree, with cracks between to provide ample ventilation. Considering that they are built entirely of local materials, without a single nail or other iron fastening, they are remarkable structures indeed; in addition, they seem very well adapted to the climate in which these people dwell.

A satisfactory collection was obtained from the environs of the village and from the surrounding grassland—nine grasses, representing the dominant and associated species which are typical of these areas.

Recently an opportunity was afforded to spend a day in the grasslands on the upper slopes of Mount Nimadao. There are appreciable differences between these higher elevation grasslands and the ones of the coastal areas. In the lowlands the dominants are kangaroo grass (*Themeda australis*), blade grass (*Imperata cylindrica*), and a species of *Manisuris*. As one ascends the mountain slopes, first the blade grass and *Manisuris* disappear at elevations of about 1,000 feet; between 1,500 and 2,000 feet the kangaroo grass gradually diminishes in quantity until, at elevations higher than these, there is left only a tufted bunch grass, which was not in flower at this time and hence could not be identified.

Such occasions as this, when one can climb mountain trails, scramble over rocky ledges, and visit new spots, are quite a pleasant holiday from routine work. Needless to say, other things than the plants catch my eye on these trips. The birds impress me, more by their vociferousness than by numbers. This applies particularly to the white cockatoos, parrots, friar birds, and pigeons. We saw hornbills—

Official U.S. Marine Corps Photo

SAVANNA, GOODENOUGH ISLAND

TROPICAL GRASSES RANGING FROM THREE TO SIX FEET TALL ARE INTERSPERSED WITH OCCASIONAL TREES. THE DOMINANT GRASSES HERE ARE *Manisuris rottboellioides* AND *Themeda australis*.

truly birds from the circus—with immense, grotesquely-shaped beaks, and loud, swishing flight like the hiss of escaping steam. I think the most interesting was a lordly eagle—the Red-backed Sea Eagle, with rich chestnut plumage, except for white head and neck, and white-tipped tail; several of them were very busily engaged in catching, of all things, grasshoppers! No accounting for the doings of the little wild folk.

At one point we came out onto the crest of a hill that afforded a view of the entire east coast of the island. Spread before us were trees, grassland; the camps on the coastal plain, with here and there thin plumes of blue smoke curling upward; and beyond that, the white breakers on the reefs and the Solomon Sea in the distance.

Goodenough Island
November 29, 1943

Dear Miriam:

Tonight I must tell you of one of the most intriguing sights I've seen in many a long day—truly something you'd never expect to see outside of fairyland.

There is here a species of small white mushroom, commonly found on wet pieces of partially rotted wood. It is a diminutive, delicate thing, never more than about half an inch across the cap, and with a slender stem not that long. Its chalky whiteness heightens the impression of frailty.

Beautiful as it is by day, it is amazingly enchanting at night. For then it becomes luminous with a pale-green phosphorescence that is so strong a watch can be read by the

glow. As youngsters we've all heard a great deal about fairies—and that a toadstool springs up whenever they want to sit down. When grown up, of course we think that all a lot of nonsense. Having seen this mushroom, I wonder if there mightn't be some truth underlying the fairy tale—and I wish so much that every child could have the privilege of at least once walking in darkness along a path bordered with these tiny, glowing, fairy jewels.

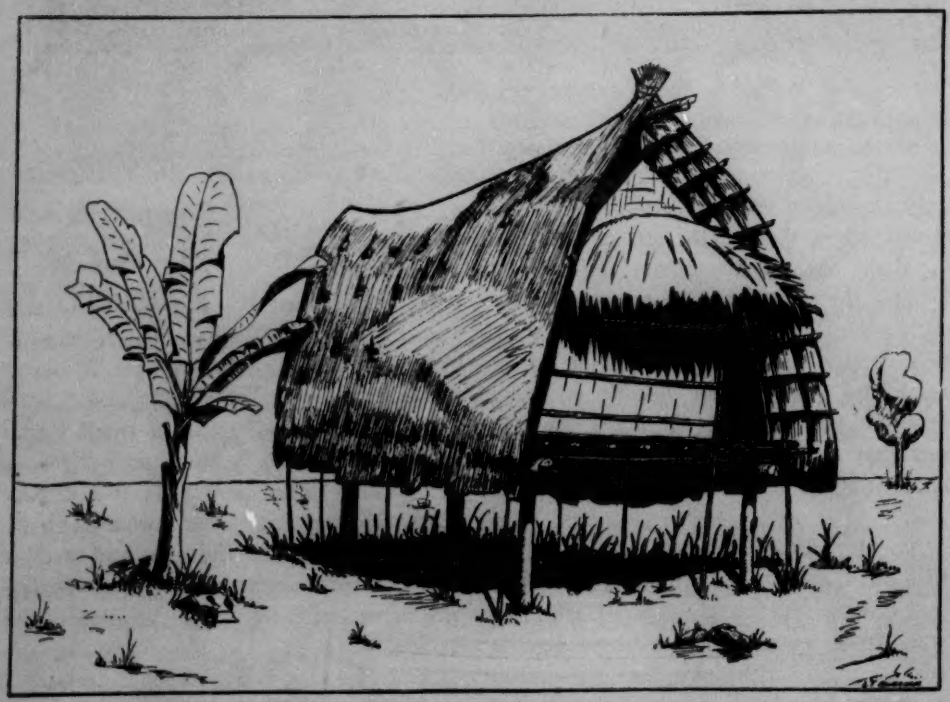
Cape Gloucester
New Britain
February 19, 1944

Dear Miriam:

When we returned to camp yesterday I had quite a stack of mail waiting—35 letters, 2 packages, and some magazines. You have no doubt been concerned over my not writing for nearly a month, but it was unavoidable.

You see, we started out on what was to have been a routine 5-day patrol—and did not return until yesterday, 28 days later. During that time we walked a straight-line distance of more than 75 miles through most interesting country; but since I went over some portions of the trail 4 to 6 times, as well as taking a few "side trips," I traveled over 125 miles. Well, I always wanted to go on an extended hiking trip; every minute of this one was fascinating.

Our purpose was to contact the natives of western New Britain, who had fled into the hills from the enemy, to tell them that it was now safe to return to their homes and to escort them back to their villages. Our patrol started from Sag Sag, at the extreme western tip of the island, and crossed the divide between Mount Talawe on the north and Mount Tangi on the south, into the interior of the island; from here we turned south and followed the Itni River to the



NATIVE HOUSE, HAIWALI VILLAGE, GOODENOUGH ISLAND

THESE SMALL, GRASS-THATCHED SHACKS, RAISED FOUR TO FIVE FEET TO KEEP OUT DAMPNESS, ARE BUILT ENTIRELY FROM LOCAL MATERIALS, WITHOUT A SINGLE NAIL OR OTHER IRON FASTENING.

Official U.S. Marine Corps Photo

WESTERN NEW BRITAIN NATIVES

HIDING FROM THE ENEMY IN THE HILLS, SOME HAD LIVED IN CAVES FOR NEARLY TWO YEARS. THIS PARTY OF WOMEN IS RETURNING TO THE VILLAGE OF AIPATI, CARRYING THEIR GOODS ON THEIR HEADS.

south coast of New Britain. Then we retraced this route to the native village of Agulupella, in the interior, and from there continued toward the northeast to strike the north coast of New Britain at Borgen Bay, and then west along the coast to our camp at Cape Gloucester.

Much of our route was through country which had probably not been visited by white men prior to this time. While I could not make any collections on this patrol, I did keep an extensive record of my observations in my notebook.

Where we crossed the divide on the south slopes of Mount Talawe was in the lower fringe of the "moss forest," which occurs above the lower limits of cloud formation on the mountain slopes. It is marked by a great increase in epiphytic mosses and ferns and other signs of constant dampness and lower temperatures; there is also a conspicuous tree with smooth, thin, white bark, resembling birch in general appearance, but not papery nor peeling as that does.

Just east of the divide was an excellent example of the virgin forests at elevations of approximately 2,500 feet. The mature trees, about 20 per acre, are from 150 to 200 feet in total height, with boles clear and straight to well over 100 feet in many instances. Most of them would average around 40 inches in diameter at breast height (4.5 feet above average ground level), with some as large as 60 to 70 inches. There is here the usual profusion of species and of mixed softwoods and hardwoods—the hardwoods including some known locally as "mahogany" and "rosewood,"

as well as teak, ebony, and eucalyptus, all of which are valuable timber trees. The crowns spread widely, forming a canopy that is almost unbroken. The soil is deep and fertile, a well-drained clay loam that is heavily humified to approximately one foot in depth and underlain with basaltic bedrock at 3 to 6 feet. There is practically no litter on the forest floor, as the dead vegetation decays almost as rapidly as it falls. While reproduction and undergrowth are plentiful, they are not dense enough to hamper movement to any appreciable degree.

We camped for the night in this forest. Rain had been falling intermittently all during the day; shortly after we stopped it began in earnest. With the assistance of the native boys guiding our party we built a leaf-thatched lean-to and found wood dry enough for a fire. We made beds of slender, springy poles placed across two small logs (thank heaven for my air mattress), cooked some rice to eke out our field rations, and dried our soaking clothes over the blaze. Sometime after midnight I awoke to see the sky clear and the ground alight with phosphorescent wood. The forest floor was black as pitch, except for the weird light of the decaying wood; phosphorescent lichens clothed the buttresses of some of the tall trees; overhead, a few small patches of starlight shone through the dense canopy of leaves. I had the enchanting sensation of floating in velvety blackness miles away in space, surrounded by glowing stars.

Borgen Bay
New Britain
April 30, 1944

Dear Miriam:

A few days ago I had a piece of bad luck —for me a near tragedy. We moved from Talasea, on the Willaumez Peninsula, traveling in open boats (LCM's) the distance of some 120 miles. During the night it rained—a tropical downpour—and in addition, the boats shipped quantities of water over the sides. And so my desk was soaked overnight in water. It contained all my papers, stationery, and drafting instruments, as well as personal books, notes, and the plant collection from the Willaumez Peninsula.

Since we landed here I've been busy as a little beaver, drying them out—but you know what happens to a book when it is soaked in salt water for some 15 hours. The bindings are ruined, the illustrations are soggy masses, and I'll have to tie them up with string to keep the pages in. The plant collection is a poor sight indeed; but, thanks to using waterproof ink, the natural-history notes are in good shape. Now I can more fully appreciate what I've read of the difficulties of travel encountered by some of the early botanists and scientists in our own country.

Tomorrow is the first day of May; I hope to "go a-Maying" and collect some of the representative species from the grasslands in this vicinity.

Pavuvu Island
Russell Islands
June 7, 1944

Dear Miriam:

For nearly a month we have been engaged in building a camp in the coconut groves which cover several thousand acres of the northwestern portion of this island. The plantation is quite a pleasant change, after months spent bivouacked in rain forests most of the time. We are located on a narrow peninsula, with small bays on either side which permit the frequent breezes to sweep across our camp, tempering somewhat the humid, tropical climate.

There are no areas of natural grassland on this island, but the coconut plantations have been underplanted with a cover crop of carpet grass (*Axonopus compressus*) and *Rhaphis aciculata*. This is a common practice throughout the Southwest Pacific where the plantations were cleared from rain forest; without such a cover crop objection-

able weeds and shrubs would invade the area before the coconut trees become established. Through the use of a cover crop, and controlling it by grazing cattle, the plantations are kept clean and free of encroaching vegetation.

The range management practices here are quite interesting and vastly different from ranching in the States. About 1,500 head of cattle and a few horses were on this island when it was retaken. The cattle are a mongrel breed, a strain of zebu, or Brahman, being the only apparent common heritage; in addition, some show traces of Hereford, or Aberdeen Angus, or Shorthorn ancestry. Although a scrawny lot, they appear thrifty and are no doubt well adapted to this climate. Since their primary function is to keep the cover crop under control, they have been left to lapse into a semiwild state. There is no evidence of care or handling beyond a few barbed-wire fences to keep them from straying into the rain forest bordering the plantation. With a heavy stand of grass, a year-long growing season, and abundant rainfall, livestock can be left to shift for themselves where the quality of the meat and purity of blood lines are matters of no concern.

Peleliu Island
Palau Islands
October 1, 1944

Dear Miriam:

There has been little opportunity for writing these past few days, as we have been rather busy—or is that an understatement! You will have guessed, and now I can tell you, that I'm in the Palau operation.

About 6 days ago I spent a day on the eastern side of our little island. There has been but little action there; consequently it retains much of its original appearance and beauty. The tiny islets, set in shallow blue-green lagoons, and white sand beaches along the coast look like a city park; it has the most exquisite small-scale tropical scenery I've seen. The white herons in the swamps, with black legs and long yellow bills; sandpipers, and cormorants along the reef; the black-and-white tropic birds, with long, trailing tail feathers—all these heightened the parklike effect.

Peleliu Island
Palau Islands
October 26, 1944

Dear Miriam:

During the past few days our outfit has been back for another inning with the little men. And now our job here is finished. During the 40 days here I've personally toured nearly 75 percent of this coral outcrop, most of it on foot. It is a violent contrast to the places we've previously visited.

Geologically, it is a most recent bit of land. As a matter of fact, the term "land" is practically an overstatement—it is a coral reef that has only recently been raised above water, with a sand bar washed up along the western shore. The soil is everywhere very scanty, slightly weathered, and mixed with bits of broken coral; in many places the trees grow in crevices in the coral, seemingly without soil. The hills retain the configuration of an underwater reef, with steep, ragged ridges, sharp cliffs, and many enclosed depressions.

Originally much of the eastern part of the island was a mangrove swamp, and the southern and western portions had a considerable cover of forest. Much of the vegetation in the south and west parts of the island, especially on the higher ridges, has been denuded by our operations. But the nature of the terrain is such that erosion will present no problem on these coral ridges; in a very few years they will again be clothed with trees.

The settled portions of the island differ markedly from the relatively uninhabited eastern part. Particularly obvious are the meager efforts at cultivation and the lack of anything resembling lawns, gardens, or parks. A very few of the more important

buildings are very poorly landscaped; for example, a circle of bare earth enclosed in a low concrete curbing in the entrance area. These attempts have been unattended for a period of years. There are no lawns—indeed, only one vestige of a suitable lawn grass was discovered—no flowers, and no ornamental shrubs. Nor have I seen, or had reported, a single temple, shrine, or any other evidence of a place of worship on this island. This in spite of more than thirty years of occupancy and in contradiction of our ideas that the Japanese expend considerable pains on their gardens, parks, and temple grounds.

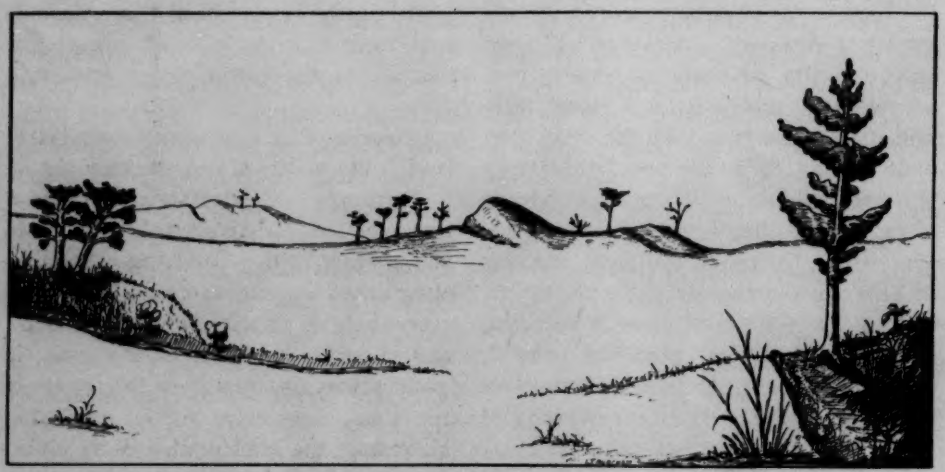
My time spent collecting grasses has been quite well rewarded. From scattered locations about buildings, in the forest, and along beaches I have gathered a total of 15 species, which I believe to constitute a complete representation of the grass flora here. And the improvised plant press I previously mentioned [the pages of a Japanese military manual printed on newsprint] has served very well indeed.

Inubi, Okinawa Shima
Ryukyu Islands
April 14, 1945

Dear Miriam:

Before answering your last letter let me tell you something of my plant collecting this afternoon. I have my plant driers along on this trip, so the specimens can be properly prepared. This being in the Northern Hemisphere, it is now spring; the spring flora is just becoming abundant, and collecting should yield some very interesting specimens. The little orchid mentioned in my last letter was from here.

It is welcome, too, to see a landscape dominated by pine trees instead of coconut palms, although the climate here is considered semitropical. The pines occurring as isolated specimens or in small groups, on coral outcrops and along the cart roads, are mostly gnarled and grotesque, the trees that are so picturesquely depicted in Japanese prints. On the ridges above the cultivated lands occur pure stands of pine woodland.



ASATO RIDGE, SOUTHERN OKINAWA

This afternoon I was collecting in one of these pine woodlands, on the ridge east of Inubi, where we are now staying. In many respects it is similar to pine forests at home. There is much evidence of heavy cutting and of considerable grazing; consequently, the stands are quite open and the trees

relatively small. On the lower edge of the woodland was a pit for making charcoal and a stack of poles evidently cut for this purpose; these varied from 4 to 6 inches in diameter and had from 10 to 12 growth rings. In other areas are stacks of firewood cut from the forests; considerable quantities of small timbers were removed from the forests for construction of defenses on the island before we arrived.

The trees in this woodland averaged about 40 feet in height and ranged between 8 and 20 inches in diameter. An understory of grasses, ferns, and low shrubs forms a ground cover that is practically continuous—among them such familiar plants as huckleberry (*Vaccinium wrightii*) and bracken fern. The close usage has destroyed much of the litter from the ground, and in many places the soil is bare and somewhat compacted.

This proved a fruitful area for collecting; I secured an even dozen grasses, many of them not previously encountered in my travels. Besides these I collected other plants typical of the understory of this pine woodland type, to give a representative cross section of the associated species.

PINUS MASSONIANA
JUVENILE SPECIMEN OF THIS PINE ON OKINAWA.

Hanja, Okinawa Shima
Ryukyu Islands
June 22, 1945

Dear Miriam:

For some time I've been intending to write telling something of this island and its people. Like all of Japan proper, and most of the Asiatic continent, the land is densely populated—here about 900 persons per square mile. The people are primarily agricultural; the farms average about one and one-half acres each and are worked on a family basis.

The land is very rough, so the fields are tiny—and extensively terraced to control erosion; the small fields also follow from the prevalence of hand cultivation to the exclusion of everything else. So small, indeed, are some of the fields that I have seen plots barely a square yard in area painstakingly terraced and planted to crops. The intensive hand cultivation, coupled with the need for maintaining maximum productiveness, results in very careful and excellent tillage methods. Crops seem quite good—to all appearances the productivity of the soil would rate better than the average of similar soils in the States. The principal crops are rice, sugar cane, sweet potatoes, soy beans, and wheat; many small plots of garden vegetables are grown for home use—cabbage, carrots, onions, tomatoes, and the like.

This impresses one as an old country, closely cropped, showing much evidence

of human subjugation and careful, painful tending. Typically, it appears a land of small farms, small houses, and small people —small people both in stature and thought. Men have made their mark on the land—unmistakably and unalterably. But one comes inevitably to the conclusion that in return the land has made just as unmistakable and just as unalterable an imprint on the lives of these people. They are subjugated by their land—their small houses, small fields, small farms. Their lives have been so completely dominated by the work of eking out a living from the soil, with the problems of home, family, and self, that they have had no time to think of anything else—nor much time to think at all: no interests beyond their homes; no thoughts beyond their horizon; and no knowledge of things outside the contacts of their immediate lives. Instead of expanding they seem to have grown into their country, their lives, and themselves. Their very civilization seems to have become static.

Motobu Peninsula
Okinawa Shima
July 16, 1945

Dear Miriam:

These lines are being scribbled as I sit with my back against a wind-gnarled pine near the edge of a 70-foot cliff. From here I have a wide view of the reefs, offshore islands, and the East China Sea. There is a fringe of pine and acacia trees along the summit of the cliff—perhaps typifying the queer admixture of vegetation from the Northern and Southern Hemispheres that one finds on this island. Here, too, we find a link with the past—a prominent member of the undergrowth is the palmlike cycad (*Cycas circinalis*), a representative of the most primitive group of present-day flowering plants.

Lately I have been prowling about the field borders, climbing the coral cliffs in front of our camp, and wandering along the rocky seashore in search of grasses to complete the collection from this area. It has yielded a number of interesting specimens. Again I have collected *Thuarea involuta*, the dainty little seashore grass that plants its own seeds, which I first encountered on Pavuvu Island. On coral outcrops along the coast I found *Ischaemum murinum*, a little-known grass that occurs mainly in the Southern Hemisphere.

Throughout the island are many vaults where the natives have interred the bones of their ancestors. Two days ago I found a tall grass, with coarse basal leaves, an erect culm, and gracefully nodding panicle, growing in a handful of decaying pine needles on the top of one of these concrete burial vaults. It was *Spodiopogon sibiricus*, of unusual occurrence on islands south of Japan; this single clump is the only specimen I have been able to find here. How it came to grow in that spot would doubtless be a fascinating story of plant distribution.

THE REDISCOVERY OF CUP BUTTE

By RONALD L. IVES
Upper Montclair, New Jersey

CUP BUTTE, perched atop an ancient gravel bar a mile above sea level, in the center of the Salt Lake Desert, is one of the least-visited geologic features in North America; yet, according to maps and descriptions published by G. K. Gilbert in 1890,* it is one of the most nearly perfect known examples of a looped bar.

The waters of Pleistocene Lake Bonneville, which formed the butte, have long since evaporated, leaving the ancient shore structure high and dry. Because of the aridity of the region, no heavy cover of vegetation has concealed or modified the surface features; and no chemical weathering has occurred to alter the original structure.

During an extensive review of the physiography of the Salt Lake Desert, it was found essential to study the shoreline features of extinct Lake Bonneville. From Gilbert's descriptions and illustration (Fig. 1), it appeared that the orientation of Cup Butte would give a very good indication of ancient current direction, and a visit to the area was scheduled.

Cup Butte is shown on only two published maps, both included in Gilbert's monograph. On the larger of these, the structure is shown at Lat. 39°54′ N.; Long. 112°47′ W.; Alt. 5,200′ m.s.l. The smaller, a detail map of the "Old River Bed" (here called the Gilbert River Bed), by W. D. Johnson, shows Cup Butte about 5 miles

*Gilbert, G. K. "Lake Bonneville," U. S. Geol. Survey Monograph 1, Washington, 138, 169, 372, 412, 419, Plate VI, 1890.

FIG. 1. SKETCH OF CUP BUTTE
AS IT WOULD APPEAR FROM A POINT ABOUT 1,500 FEET IN THE AIR ABOVE THE ANCIENT GILBERT RIVER BED. THIS FIGURE, FROM GILBERT'S REPORT, HAS A VERTICAL SCALE ABOUT 2.5 TIMES THE HORIZONTAL.

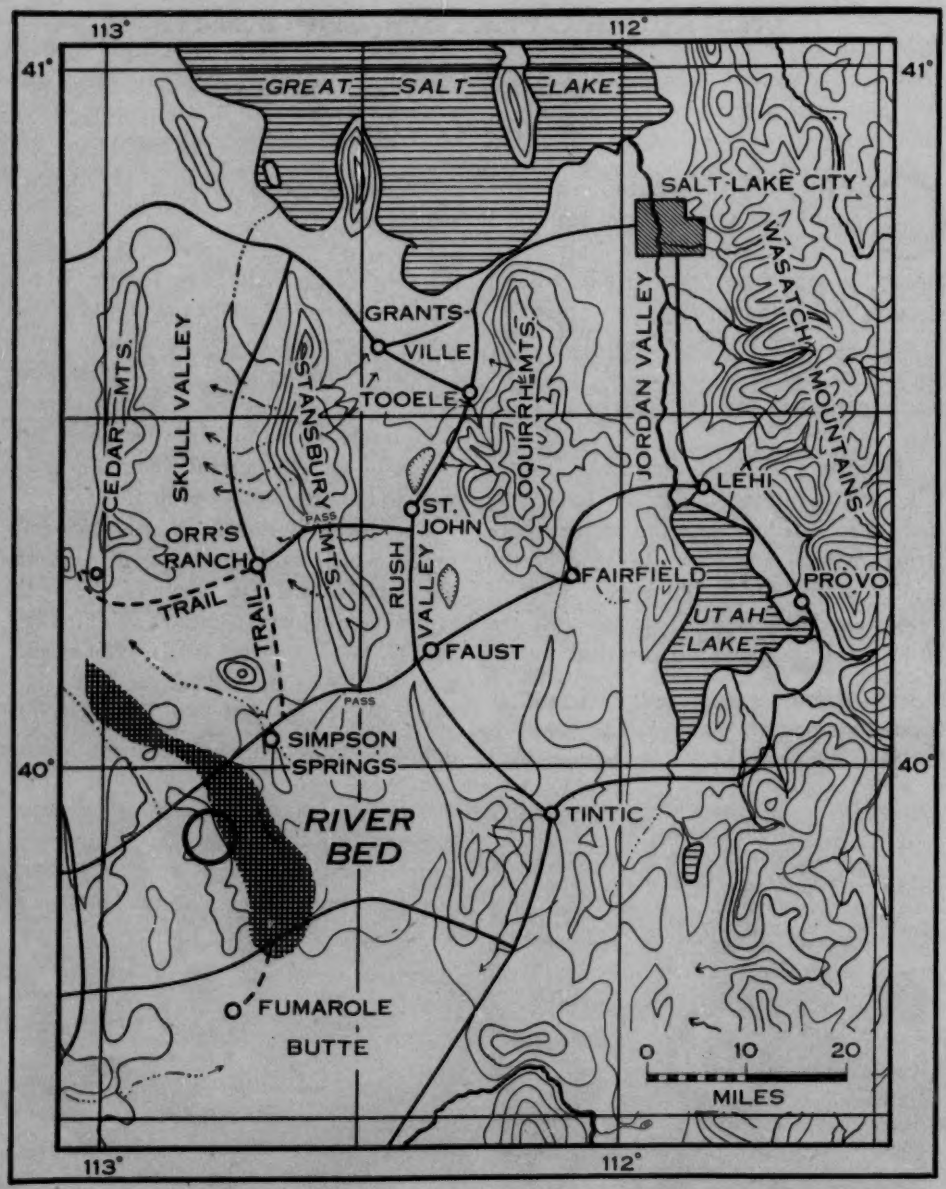


FIG. 2. SKETCH MAP OF A PART OF THE UTAH DESERT AREA

SHOWING LOCATION OF THE GILBERT RIVER BED (CROSSHATCH), AND THE AREA WITHIN WHICH CUP BUTTE WOULD PROBABLY BE FOUND. CONTOUR INTERVAL IS ABOUT 1,000 FEET, LOWEST CONTOUR 5,000 FEET.

south of the River Bed stage station, 7 miles west-northwest of the Bonneville shoreline above the "Snowplow," and 11 miles southwest of Simpson Springs. Gilbert (p. 55) locates and describes the structure as "an island of Lake Bonneville standing on the desert near what is known as the 'Old River Bed.'"

The "Old River Bed" was a definitely recoverable site, as was Simpson Springs, site of a former CCC camp; but the River Bed stage station has long since disappeared

FIG. 3. RESERVOIR BUTTE, ON THE WEST SIDE OF THE GILBERT RIVER BED

THIS IS ONE OF THE MOST FAMOUS SHORELINE STRUCTURE SITES IN THE WORLD, A BAR HAVING BEEN BUILT ON THE FLANK OF THE MOUNTAIN AT EACH STADIUM OF PLEISTOCENE LAKE BONNEVILLE. THIS PHOTOGRAPH, TAKEN FROM THE SOUTHEAST, ALMOST EXACTLY DUPLICATES GILBERT'S SKETCHED PLATE XXIV.

and has been replaced by a historical marker on the presumed site. From the geographic descriptions and Gilbert's sketch (Fig. 1), it appeared that Cup Butte was somewhere within a 5-mile circle, on the west side of the River Bed, south of Reservoir Butte (Fig. 3). The location of the search area, in relation to major features of the Utah Desert area, is shown in Figure 2.

Inquiries among local miners and ranchers disclosed that few had ever heard of Cup Butte and that several were very certain that there was no such feature near the River Bed "or anywhere else in the world." In contrast, Mr. Daniel T. Orr,† pioneer rancher of Skull Valley who had once worked for Gilbert, declared most emphatically that if Gilbert had described the feature, it was there.

†A most helpful and dependable informant. The trilobite *Orria elegans* was found by, and named for, Mr. Orr.

Because of the dependability of Gilbert's work, we decided to disregard the local negative information and, with Gilbert's maps and description as a guide, to attempt to find Cup Butte.

PRELIMINARY to detailed ground studies, an aerial reconnaissance of the River Bed and the adjacent mountain region was made, with the skilled pilotage of the late George Langham, Captain, A.C. This study indicated that Johnson's map of the Old River Bed (Gilbert, *op. cit.* Plate XXXI, opp. p. 182) was at least substantially correct, although somewhat distorted because of a local magnetic attraction (probably caused by buried volcanic materials). Cup Butte was not seen from the plane, owing to "bad seeing" and the rough air characteristic of desert mountain regions.

Following the aerial study, a jeep traverse of the Old River Bed was made in company with the late Master Sergeant De Vore, M. C.

During this journey, on which the jeep was taken where nothing on wheels had ever been before, Reservoir Butte (Fig. 3) was identified, Gilbert's "Snowplow" structure was found, and Fumarole Butte (Fig. 2), with its accompanying hot springs, was visited. Cup Butte, however, remained unfound.

To narrow down the search area, a visual reconnaissance was made from the summit of Reservoir Butte, a weird combination of a desert mountain and a group of shoreline structures (Fig. 3), which overlooks almost all the ancient shoals and shorelines of Lake Bonneville in this general vicinity.

Although these visual observations were made very difficult by bad seeing, resulting from the "boiling air" common to the desert, they showed conclusively that if Cup Butte existed, it was in a small area atop an ancient shoal, defiladed by a quartzite butte southeast of Reservoir Butte. This remaining search area, approximately 1.5 by 2.5 miles in extent, was centered about a point 3 miles southeast of Reservoir Butte. Cup Butte—if present, should be visible from Bar Hill, another high point, about 5 miles south-southeast of Reservoir Butte.

Accordingly, when circumstances permitted, a jeep ascent of Bar Hill was made from the south, the chosen trail winding back and forth over a series of ancient gravel bars built across the mouths of local valleys during various stages of the ancient lake.

From the northeast side of the summit of Bar Hill, the ancient shoal area which could not be seen from the top of Reservoir Butte was plainly visible. These former shoals are now a mesa, flanked by 35° angle-of-rest talus slopes. Through the desert air, boiling despite the zero temperature of early February, a small knoll of gray rock, shaped like the "horn" of Cup Butte (Fig. 1), was dimly visible on the extreme southeast end of the highest

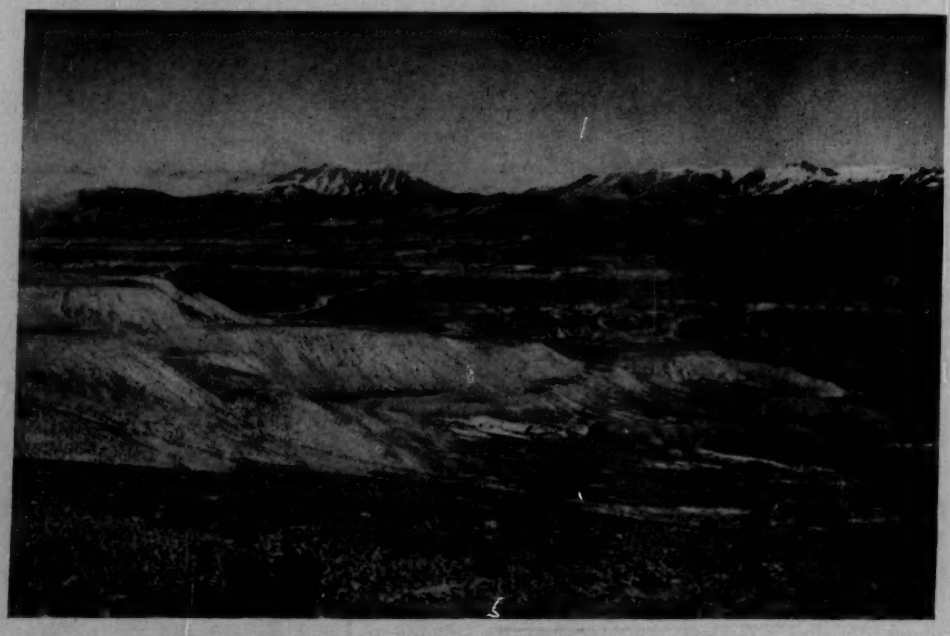


FIG. 4. VIEW NORTHEAST FROM BAR HILL

SHOWING ANCIENT BARS AND SHOALS WEST OF THE GILBERT RIVER BED. HIGHEST LEVEL CORRESPONDS TO THE BONNEVILLE SHORELINE; CENTER LEVEL IS THE INTERMEDIATE; LOWEST LEVEL IS THE PROVO. THE SIMPSON MOUNTAINS ARE IN LEFT DISTANCE; THE GILBERT RIVER BED IS IN MIDDLE DISTANCE. THE SUSPECTED LOCATION OF CUP BUTTE (LATER FOUND CORRECT) IS AT THE RIGHT END OF THE HIGHEST TERRACE.

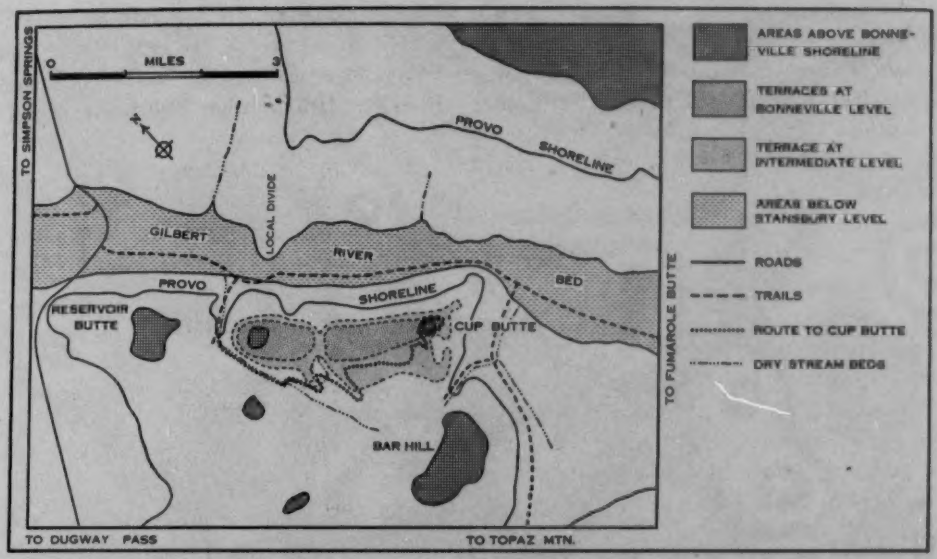


FIG. 5. SKETCH MAP OF THE GILBERT RIVER BED AREA

SHOWING LOCATION OF RESERVOIR BUTTE, CUP BUTTE, BAR HILL, AND THE ROUTE TAKEN TO REACH CUP BUTTE.

terrace level. If Cup Butte existed, this was it! A general view of the area comprises Figure 4. All that now remained was to find a trail to this structure.

Topographic study from the summit of Bar Hill showed that the best route to the supposed location of Cup Butte was up a dry wash to the west of the shoal area and that this route was certain to be rather difficult.

Using a jeep which had been specially "tuned up" for climbing, we followed the River Bed trail from the Simpson Springs—Dugway Pass Road to the highest point in the Gilbert River Bed—and a branch trail up the dry wash to the west. From the end of this trail, the dry stream bed was followed for about a mile (Fig. 5), and then a tributary wash for about 1,500 feet. By making a number of switchbacks, the intermediate terrace level, about 200 feet below the Bonneville, was reached with no more difficulty than was experienced in climbing Bar Hill, although the course was somewhat devious because of a random arrangement of large beach boulders at several locations. From the intermediate level to the summit, however, it appeared that the 35° boundary slope of the Bonneville terrace, composed of loose, angular talus, would have to be climbed. This, theoretically, was beyond the ability of a jeep.

Almost directly below the supposed location of Cup Butte, at the edge of a steep "drop off," one area was found in which the talus seemed to be quite firm. After several attempts to climb this slope in "low-low" and "four-wheel," the pulling power of the jeep was increased slightly by disconnecting the fan and generator, and the traction by partly deflating the tires. On the next attempt, the jeep shuddered onto the flat surface of the Bonneville level of shore deposits. After reconnecting the fan and pumping up the tires, we reached Cup Butte by threading a maze of boulders.

Locations of principal topographic features, roads, trails, and the route followed to Cup Butte are shown in Figure 5, a sketch map based on W. D. Johnson's (Gilbert, Plate XXXI, opp. p. 182). A view of Cup Butte from the south, showing the "horn," and with the jeep on the rim to give scale, comprises Figure 6.

FIG. 6. CUP BUTTE, AS SEEN FROM THE SOUTH RIM

THE INTERIOR OF THE BOWL IS ABOUT 250 FEET LONG, 175 FEET WIDE, AND 40 FEET DEEP. THE "HORN" IS ABOUT 30 FEET HIGH. THE JEEP SHOWN ON THE RIM OF THE CUP INDICATES THE APPROXIMATE SCALE.

BECAUSE of the probable importance of Cup Butte in many investigations of ancient Lake Bonneville, two additional visits were made to the site in an effort to secure accurate location data.

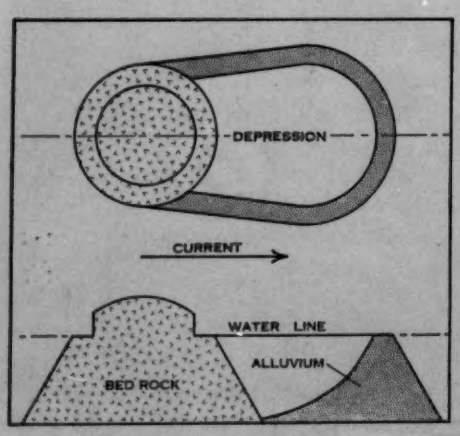


FIG. 7. A LOOPED BAR

UPPER FIGURE IS A PLAN VIEW, WITH THE SECTION PLANE PASSING THROUGH THE WATER LINE. LOWER FIGURE IS A VERTICAL SECTION, WITH THE PLANE PASSING THROUGH THE AXIS OF THE STRUCTURE.

By triangulation, Cup Butte was found to be 9.33 miles S.37°W. of the Simpson Springs historical marker, the probable error in this measurement, after curvature and refraction errors, being 0.1 miles and one degree of arc.

By corrected aneroid barometer, the following altitudes were determined: Top of horn, 5,240′; rim of cup, 5,210′; bottom of bowl, 5,170′; all altitude differences being correct to less than 5 feet and all being above mean sea level, with a probable error not exceeding 25 feet.

Determination of geographic position by means of a sun sight was not possible because of boiling air. Position as given by the average of a number of star sights, taken after midnight in March 1946, indicates that the latitude of Cup Butte is 39° 56′ N. and the longitude 112° 48′ W.; both determinations having a probable error of one minute of arc, owing in large part to atmospheric unsteadiness and in lesser part to lack of refraction data for a

FIG. 8. EAST WALL OF CUP BUTTE, AS SEEN FROM THE "HORN"

SHOWING THE TWO SEQUENCES OF DEPOSITION. MATERIAL ON THE FLOOR OF THE CUP, AND FORMING THE RIGHT (SOUTH) WALL, IS COMPACTED AND WEATHERED; WHILE THAT IN LEFT CENTER IS LOOSE AND SUBSTANTIALLY UNWEATHERED. THIS LOOSE MATERIAL FORMS A THIN VENEER OVER THE OLDER MATERIAL.

high point a mile above sea level. Some discrepancies in the locations computed suggested atmospheric stratification.

Magnetic north, atop the butte, was found to be 22° east of true north as determined by a star sight. Several other determinations indicate quite plainly that there is a local magnetic attraction in the Gilbert River Bed area, probably most intense in the vicinity of buried volcanic structures ("Local Divide," Fig. 5).

Corrected bearing of the center line of Cup Butte is 322°. This indicates the direction from which the formative currents came and, with slightly less accuracy, the source of the resultant dynamic wind during Bonneville time. Modern observations, made in an area on the delta of the Gilbert River, about 15 miles northwest of Cup Butte, indicate that the resultant dynamic wind now comes from about 309°‡. The difference of 13° between ancient current direction and modern wind direction is not regarded as significant in view of the geographic separation of the points of observation. A statement that the source of the resultant dynamic wind has not changed since at least the later Pleistocene seems entirely justified.

According to generally accepted theories of bar formation, a looped bar, such as Cup Butte, will be formed when a debris-laden current impinges on an obstacle of relatively small dimensions so that, after parting, the current passes on both sides of the obstacle. Debris is deposited at the margin of the slack water behind the obstacle. The general structure of Cup Butte is exactly as called for by this theory.

A generalized section of a looped bar, slightly idealized for clarity, comprises Figure 7. Similarity of this figure to

‡This figure is an average of two determinations and is in general accord with wind-constructed topographic features in the same area. Ives, R. L. *Amer. J. Sci.*, **244**, 492–501, 1946.

Gilbert's sketch (Fig. 1) and the text illustrations (Figs. 6, 8) is marked.

Detailed study of the deposits comprising the walls of the cup indicates that construction was a "two-step" process, the major part of the work being relatively old and present as compacted and weathered bar material. Over this was deposited a thin layer of loose, angular rock fragments, which appear relatively much newer than the material forming the major part of the butte (Fig. 8).

From this evidence, which is also present elsewhere, it is concluded that the waters of Lake Bonneville rose twice to the level of Cup Butte, remaining at that level for a relatively long time during the first rise and for a very short period during the second. Comparison of deposits in this area suggests that the first rise was that usually classed as Bonneville and that the second was approximately contemporaneous with the Provo stage.

Field checking of Gilbert's description of Cup Butte shows that his work, done more than 60 years ago, was as accurate as the state of the art permitted. Although modern methods of observation and transportation accelerate field work somewhat, the only great improvement in surface geological field methods since 1885 seems to be the general use of photography.

In view of the chronic bad seeing in the Salt Lake Desert and the paucity of topographic control points in 1885, the accuracy of Gilbert's cartographic work is notable.

Although Cup Butte, because of its isolation, will probably be visited very infrequently, this excellent example of a "fossil" looped bar can be located with very little difficulty from Gilbert's original maps and descriptions. During the early part of the winter of 1945–46, Lieutenant Colonel P. A. Leighton, C.W.S., located and ascended Cup Butte, using only these data. With the additional trail and location data here presented, Cup Butte should be reachable, on first attempt, by any competent field worker.

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IMPRESSIONS OF JAPANESE MEDICINE AT THE END OF WORLD WAR II*

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AMERICAN Occupation Forces who arrived in Japan shortly after the surrender were afforded an excellent opportunity to observe the defeated enemy about whom we had heard so much and to evaluate some of the concepts which were formed during the conflict. Curiosity was especially high among American medical officers concerning the state of Japanese medical practice and the effect which the war had upon it. The remarks which follow are based upon impressions received during 16 weeks on the Island of Kyushu between September 1945 and January 1946. Six weeks of this period were spent supervising the activation of a Japanese hospital in Nagasaki. This meant close daily contact with native physicians, nurses, and civilians who were making the first attempts at revitalizing a profession which had been terribly crippled by the catastrophic events of preceding years.

Until recently, Nagasaki possessed a major medical center and boasted one of the finest medical schools in Japan. Its buildings were handsome, modern, and built to withstand earthquakes. The concrete frames of these buildings now stand alone on a vast expanse of rubble. They were about two-thirds of a mile from the center of the atomic bomb blast. Eighty percent of the 800 persons in the buildings were killed outright, including all but 4 of the medical professors and most of the medical students, nurses, and patients.

* The opinions expressed are those of the author and not of the Navy Department.

† The author wishes gratefully to acknowledge the aid of Lt. Walter D. Roberts (MC) USN in gathering material for this paper.

BOMBED AREA SEEN FROM KYUSHU MEDICAL SCHOOL

JAPANESE TECHNICIAN
IN THE TEMPORARY HOSPITAL IN NAGASAKI.

Most of the deaths were caused by the heavy plaster ceilings, which were pulled down by the blast. The odor of decaying bodies was still heavy in some of the rooms 4 months after the bomb fell.

Judging from the equipment which remained in the ruins of the large medical center, its physical plant would have compared favorably with most modern Western institutions. There were separate buildings for dermatology, gynecology, ophthalmology, neuropsychiatry, etc. Each department had several laboratories and showed evidence of active research and teaching programs. There were many wax and plaster models and large collections of medical photographs. Many gross and microscopic specimens were also found in the ruins.

With the loss of its principal medical center, Nagasaki was virtually without hospital facilities until the arrival of the American forces. Consequently, victims of the atomic bomb received inadequate care or no medical attention at all. The Japanese had converted one school building into a hospital for their treatment and study prior to our arrival, with a staff composed of survivors of the medical school faculty. This was probably the best hospital in the area.

In December 1945, four months after the atomic bomb, Japanese authorities told us that there were about 300 hospital beds in the Nagasaki area, divided among some 30 small hospitals. This would provide 1 bed for each 500 of the population. Although some of these hospitals were quite acceptable, most of them were in small houses of mud and bamboo that were hardly worthy of the term "hospital." About all they offered was the sympathy of a physician and a space on the floor to rest.

One of the larger institutions was the women's venereal disease hospital of about 50 beds, the "beds" consisting of straw mats on the floor. There were no other furnishings in the rooms, and 6 to 8 patients were crowded into an area which was adequate for about two. Each patient had her few belongings piled in one corner of the mat which covered her area. The rooms were dark, filthy, and fetid. Treatment rooms were littered with ancient instruments and old, dusty bottles. Aseptic technique was not observed, and instruments were sterilized by dropping them into a caldron of water boiling on a charcoal stove. One gynecologist was in attendance. Medications which were available were very inadequate.

At Omura, which is about 25 miles from Nagasaki, there was a large naval hospital built for temporary wartime use. This was excellently equipped for about 2,500 patients, but was not in use because of the lack of personnel and the state of general confusion which prevailed. In Sasebo, about 75 miles north of Nagasaki, were two naval hospitals of a combined capacity of six or seven hundred patients. These hospitals were also idle.

In order to relieve the chaos, and also as part of the demobilization program, Japanese Army and Navy medical stores and equipment on western Kyushu were pooled and brought to Nagasaki for distribution. The prefectural government was instructed to provide a suitable building and to hire the required labor and staff for the establishment of a hospital in the shortest possible

time. Though the projected hospital could not hope to care for more than a token number of the needy, it would be a step in the right direction.

A modern concrete building in a section of the city which had not been damaged by bombing was chosen for the site. The hospital was to contain about 150 beds and meet American standards. In the course of 3 months it was converted into an effective hospital. Japanese interpreters told us that, if left to their own methods, the same project would have taken a year to complete. American prodding was needed continually to initiate and carry out this project; the fact that it was intended solely for the benefit of the Japanese did not seem to be an inducement for them to work on it.

Most of the building-trades men were highly skilled, though their tools and methods were antiquated and everything was done by hand. Evidence of wartime shortages was ever-present and was emphasized by the skills which workers had developed. For example, the carpenters were able to work with few nails; they also substituted a string coated with lampblack to mark their work instead of using a pencil. Their tools were always very keen, and their work tidy.

Women and children, as well as men, are employed in the building trades in Japan. When it was necessary to cut a space for a door through a heavy reinforced-concrete wall, the task was assigned to an old woman of about seventy years and a boy of twelve. Both thumped with a mallet and chisel for 2 weeks while all other work in the vicinity was held up because of the dust they created. Two men could have done the job in 3 days.

A great deal of equipment was salvaged from the ruins of the medical center; operating tables, electric refrigerators, surgical lamps, furniture, and sinks were found in good condition. Though all these things had been in the ruins for 4 months and permission had been granted to remove what was needed, the Japanese made little effort

EMERGENCY HOSPITAL

FOR THE JAPANESE UNDER AMERICAN SUPERVISION

to do so until specifically ordered. Occasionally one would see a solitary medical student wandering through the ruins of his school looking for something to take home.

The beds for the hospital were procured from the Omura Naval Hospital. These were sturdy Western-style wooden beds with thick straw mattresses. The bed linens were made from bolts of airplane cloth from a nearby airfield.

The water supply came from the city water mains. Nagasaki had been one of the few cities in Japan with a modern water purification system that had not been seriously damaged by the war. Repeated tests showed the water to be satisfactory. However, experience made us hesitant about relying upon its potability. For example, it was usual to be able to culture all the common bacterial enteric pathogens from the city water of Sasebo.

Each floor of the hospital building had one hot-water heater in the hallway. This consisted of a tank which contained coils attached to the central steam-heating system. Since there was no coal for the furnaces during most of the winter, there was no hot water.

The hospital kitchen was light and spacious and was lined with white tile. The cooking was done in large pressure caldrons heated from the central heating plant. The diets were very meager since no special

foods were available for hospital patients. The diet consisted of rice, a few greens, some citrus fruit, and a little fish. On the rare days when fish was obtained, its preparation forced the American occupants to leave the building in search of fresh air.

THE Japanese Army and Navy medical supplies were of considerable interest, although language difficulties prevented identification of all the items which were seen. Military medical equipment was usually packed in sturdy wooden packing cases with cloth or leather handles on the ends and a hinged top. Some of them were adapted for transport on horseback. Within the outer cases, there were highly polished and varnished smaller boxes with many compartments. These appeared to be handmade and were fitted with brass corners and elaborate hardware. After opening several boxes within boxes, one would finally find a small object such as a glass funnel or test tube.

Each box was prominently marked with a Red Cross. This was striking in view of the fact that such markings on Allied equipment in the Pacific combat areas were not only disrespected by the Japanese but rated a high priority as targets. Some of the cases were made of heavy leather and lined with wicker. There were many test-tube racks, alcohol lamps, bacteriological stains, and small kits of surgical instruments in aluminum containers, mostly of Japanese manufacture.

Most of the surgical instruments were plated with a metal resembling chromium, which was often chipped and ravaged by rust. The tooling was inferior, and only a small percentage of the hemostats and similar objects were in workable condition. A few German instruments were seen which were decidedly better. Such instruments as microscopes, cystoscopes, and sigmoidoscopes were made in Japan.

There were portable X-ray machines which were very compact and reported to be very efficient. The principal unit came in a canvas case the size of a bowling ball and weighed about 50 pounds. We were told that these were dental units but that

KYUSHU MEDICAL CENTER

THESE BLASTED BUILDINGS ARE SITUATED ON THE EDGE OF THE AREA DESTROYED BY THE BOMB

BOMB DAMAGE TO THE KYUSHU MEDICAL CENTER

they were frequently used for other work as well.

A large X-ray machine was procured for the hospital, but, like so many other objects, it had one important part missing, so it was useless. No one could locate a tube for it. Finally several were obtained—they were the wrong size. An excellent darkroom was set up; it had one essential chemical solution missing, so no work could be done there either. Several packages of X-ray film, sealed and marked with Japanese manufacturers' labels, were procured. On opening them and examining the film it was seen to bear the mark "Property of the U. S. Government—Eastman Kodak Company."

We also came across some large, complex, cumbersome machines that resembled small steam engines. We learned they were formaldehyde vaporizers and were used to spray the air in a sickroom.

The most plentiful object in all the stores was the Westergren type of erythrocyte sedimentation apparatus. There were thousands of the tubes and several large truckloads of the wooden racks, most of them used. We learned that the sedimentation rate is a highly favored procedure and is widely used by the Japanese doctors. Readings are made after 1, 2, and 24 hours.

Most of the commonly used pharmaceutical preparations which were seen in the United States before 1940 were found in the warehouses. These were mostly Japanese brands. Labels were in Japanese and Latin or English. Many of the drugs were packaged in gaily colored glass ampoules. These varied from a fraction of a cubic centimeter to a 500-cc. capacity. It was not possible to learn what all of them contained.

Morphine was packaged as a white powder in cork-stoppered bottles of about 30-gm. capacity. There were many vitamin preparations in the form of pills, capsules, ointments, or combinations with other drugs.

There was a granular white powder resembling calcium chloride which came in yellow plastic containers. This was found in large quantities and was intended as a universal protective agent against war gases. There were also large kits with complicated

apparatus and pictorial instructions for using them in combatting chemical warfare agents. There were thousands of well-made gas masks of conventional design.

Sulfonamides were found in fair quantity, but the Japanese doctors had little faith in their own brands and would much prefer to try the American products if given the opportunity. They were also a bit uncertain about the indications and contraindications for these drugs.

Penicillin came in small black paper packages and was prepared in two forms. One was a small green pellet of compressed powder for oral administration, and the other was for parenteral use. The doctors told us that there was very little of this drug available and that it was distributed to the Army principally for morale purposes as they had heard a great deal about its use by Americans. When asked about the efficacy of the Japanese product, one of the doctors laughed and shrugged as he replied, "No gutt." The Japanese apparently had no means of refrigerating such perishable products.

There were few biological preparations other than some diagnostic antigens and cowpox vaccine. The cowpox was dispensed in 10- to 30-cc. quantities in bottles. No insulin or liver extract was found.

Some difficulty was encountered in establishing a laboratory for the hospital since no experienced technicians could be obtained. The Japanese physicians were accustomed to performing their own laboratory tests at the bedside, and, if not watched, all the equipment which was brought to the laboratory would soon find its way to the wards throughout the building. This caused much loss of time and duplication of work.

In order to remedy this situation, a young physician was hired to take charge of the laboratory. He was the son of a distinguished professor of medicine and had spent a year in the Imperial Navy after completing medical school. His training had been shortened by the accelerated program during the war, and he felt that it was not up to par. He learned the laboratory work very rapidly and soon trained a young girl as an assistant.

Marble table tops, sinks, centrifuges, incubators, and the like were brought from the atomic bomb ruins. An electric refrigerator, which was probably one of the very last ones in existence in the city, was placed in the laboratory. It was soon realized, however, that there was nothing to put in it.

The bulk of the work submitted to the laboratory in its first weeks of operation consisted of bacteriological smears, urine, and blood for sedimentation rates. It was very difficult to keep the laboratory clean because of the reluctance of the Japanese workers to dispose of old specimens. These would be found scattered about the floor in spite of repeated criticism. Cleansing of glassware was hindered by the lack of soap and hot water.

In Japan, the physician is a respected and important member of the community. In spite of this, his clothing is now almost as tattered as that of the poorest peasant and his diet has the same deadly monotony. He wears remnants of his Army or Navy uniform with a metal pin on the cap to identify his profession. He walks to work or, if he is fortunate, pedals a bicycle. Though the prefectural government had several automobiles, the only motor vehicles in the hands of local medical people were two motorcycles which belonged to the two gynecologists. The hospital was unable to procure an ambulance.

Five physicians and 3 interns, all graduates of the Nagasaki Medical School, comprised the staff of the hospital. Most of them had been second lieutenants in the Army who had been on overseas duty. They were an industrious group and exhibited the attitude of sympathy which identifies their profession elsewhere in the world. They were pitifully ignorant of

recent development in the world of science and immensely curious about American methods and equipment. Even the older ones showed no hesitancy about coming to a young American doctor with questions, much as a student consults a professor. No medical literature dated later than 1935 was encountered. However, these physicians were familiar with most of the standard American textbooks of medicine and surgery published before that time.

Shortly after work on the building was started, prospective patients began to gather at the front door, and it was decided to open several out-patient clinics while the construction was still going on. It soon became necessary to place a few of the more serious cases on the wards for treatment. Thus, by the time the hospital was ready to open, it was well filled with patients.

In view of the exceedingly bad food situation, families were permitted to bring food to the patients. This usually consisted of some rice and a few tangerines. It never was difficult to keep the patient's fluid intake at a high level as there was always a pot of hot tea at the bedside.

When a young child or its mother was a patient, both remained in the same bed. If there were six patients in a room, one would always find at least that many friends and relatives in spite of vigorous attempts to restrict the hours of visiting. This gave the place the appearance of a family hotel. Since the heating system was not functioning most of the time, patients brought heavy quilts to the wards with them.

The contagious rooms were enclosed in glass. Outside of the door was a clothes tree with surgical gowns and a table with a pan of antiseptic solution. The effect of these was principally psychological. When an infant was ill and its mother in bed with it, the task of indoctrinating her into contagious technique was a formidable one.

In the first 15 days there were 800 patients in the clinic. They were charged fees based on a complex point system. Each therapeutic procedure was given an arbitrary point value which was multiplied by a conversion factor to determine the bill. The conversion factor was subject to daily fluctuations as economic conditions changed. The highest point value was assigned to the performance of a *corpus callosum* puncture. This was worth 500 points. Simple dressings would average 3 to 10 points. Several hundred major and minor procedures were thus listed.

The first 800 patients paid a total of 271 yen. At that time, there were 15 yen to the American dollar. A carton of cigarettes sold on the black market for 125 yen, and a respectable kimono was priced at 500 to 1,000 yen. The doctors in the hospital were paid a salary of 600 to 1,000 yen per month.

The surgical clinic provided a vast amount of pathological material. The doctor in charge labored long hours, as did the interns who assisted him. Nonambulatory patients were brought in on stretchers of bamboo or on small two-wheeled carts. There were no agents available for general anesthesia, so local anesthesia with procaine was used for the only procedures that could be carried out. During this period, one often wondered what became of those unfortunates who developed acute surgical emergencies such as perforated ulcer or appendicitis.

For a surgical scrub, the surgeon used a small enamel basin with a few ounces of medicated soap and a piece of gauze to rub his hands. After several minutes of this, chlor-cresol solution was rubbed in. An abbreviated surgical mask was worn continuously by those who worked in the clinic. The idea was apparently to protect the wearer of the mask rather than the patient. All surgical dressings were impregnated with acriflavine, a very popular drug.

We watched for evidence of the stoicism

which is reputedly a Japanese characteristic. Only one example was seen in the clinic: a young man who underwent a finger amputation under rather unfavorable circumstances. Japanese children were noisy and afraid of the doctor, much as children are elsewhere in the world. Those treated by Americans in a large charity hospital in the United States were judged by the author to be much more stoical than their young counterparts in Japan.

Failure of the steam fitters to produce steam in the large autoclave which had been procured for the hospital necessitated improvisation of other methods of sterilization. Small objects were sterilized by the Japanese by boiling, and larger objects such as trays were "sterilized" by swabbing them with a flaming alcohol sponge.

The instruments which the physicians used were often in need of repair and sharpening. This brought to mind a contrast between their equipment and that of the carpenters—the carpenters took time to sharpen theirs daily. Silk sutures were used exclusively; no catgut was available, and cotton was very scarce.

MANY victims of the atomic bomb came to the clinics. Their treatment consisted principally of simple surgical dressings. The wounds during this period (4 to 5 months after the bomb) were granulating third-degree burns, remarkably dry and free of infection in spite of extremely poor hygiene on the part of most of the patients. Many patients bore dense, disfiguring scars, and contractures of the extremities were beginning to present themselves. None of the victims received plastic surgery, nor were attempts at skin grafting made. The injuries resembled those of common thermal burns, although some were pigmented as has been observed following excessive X-ray exposure. There was some alopecia, but at this time most of the victims had new hair growing in the injured regions.

The attitude of civilians toward the bomb was difficult to discern. It often appeared that their only response was one of admiration of such a magnificent weapon. There was no outward exhibition of bitterness or animosity, and those who had escaped injury spoke freely of the spectacle and even joked about it.

Treatment procedures which were carried out in the clinics were orthodox for the most part. Some methods were unusual, however. The following is a summary of some of the things which were observed.

A comatose male with a severe basilar skull fracture was treated with artificial respiration and application of camphor in oil to the scalp locally. An old compound fracture of the tibia with nonunion and a warm fluctuant abscess with tense red skin overlying it was given local applications of sulfanilamide ointment containing vitamins A and D.

Pyogenic infections of the skin, which were very common, were dressed with mercurochrome and acriflavine gauze. A massive cold abscess of the subcutaneous tissues of the back was incised and drained, and the patient made ambulatory. Weeping eczema of the scalp was treated with boric acid ointment, followed by sulfonamide ointment.

Psychiatric disorders were infrequent. Such patients were given barbiturate sedation and were sent home under the care of a relative or friend. Coronary thrombosis was recognized as a clinical entity and was treated with digitalis and bed rest. Diabetes was not observed in the clinics. The internist had seen only about 50 cases of the disease during the past 15 years.

There were many upper respiratory infections. The Japanese physicians showed no hesitancy in diagnosing diphtheria on physical examination only. On several occasions the American forces became concerned about the number of cases of diphtheria in the native population, but repeated bacteriological examinations did not confirm the diagnosis in most instances.

Burns were treated in much the same manner as other superficial injuries. There was an abortive attempt at debridement, and various ointments were applied. The patients were filthy and usually returned with their dressings in tatters. No parenteral therapy was seen even in the more serious cases. Despite all this, the burns healed well.

There were thousands of 500-cc. ampoules of Ringer's Solution in the medical warehouse. This was the principal agent used for the treatment of shock and was said to be an expediency brought on by the scarcity of prepared human plasma. Plasma was used by the Army for severe cases only and was reserved for use on the battlefield in the tropics. The Japanese doctors said that they used Ringer's Solution extensively and found it efficacious, although they admitted that it was not as satisfactory as plasma. They also used it to prevent dehydration but rarely gave over 500 cc. per day even in cases of severe dysenteries.

Blood was administered on the battlefield by direct transfusion of 50-cc. quantities, using a syringe. Another method of so-called transfusion, which was observed in Japanese hospitals, was the removal of about 10 cc. of blood from the arm and injecting it into the buttocks intramuscularly. This was one of the methods used to treat the anemia of victims of the atomic bomb.

The nurses who assisted in the clinic were very helpful and appeared to be well trained. They were cheerful and worked quickly and quietly. They lived on one of the wards of the hospital and cooked their meals over a charcoal stove in the back yard.

It soon became evident that a number of serological tests should be done by the hospital. Since there was an ample supply of antigen for the Murata test, it was tried in order to compare it with the Kahn reaction with the hope that it could be used routinely.

The Murata test is a ring test for syphilis which is widely used by the Japanese and is a modification of the Sachs-Georgi reaction. It is a rapid and simple technique but in our hands did not compare favorably with the sensitivity of the Kahn test. It produced a positive test only with those sera which were very strongly positive with the Kahn Presumptive test. It is unlikely that this was due to deterioration of the antigen, as it was packaged in sealed glass ampoules.

About 3,000 sera were examined in this laboratory and in American hospitals in the vicinity. With the Kahn test, about 80 percent of the dancing girls and geishas were positive, and 50 percent of the civilians tested were positive. The Murata test gave only 1 positive result for each 10 positives with the Kahn.

When the hospital was finally completed and ready to open, it was turned over to the faculty of the Nagasaki Medical School. They appeared to be overwhelmed and a bit incredulous at this gesture. These men will form the nucleus around which Nagasaki medicine will be revived. Their task will require many years of conscientious labor in the face of adversity which could hardly be more severe.

THE BRITISH NATIONAL PHYSICAL LABORATORY

By H. BUCKLEY

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INTERNATIONALLY, the best-known scientific institution in Great Britain is undoubtedly the National Physical Laboratory. It is the largest of the research stations of the British Department of Scientific and Industrial Research, covering more than 60 acres in the thickly populated London suburb of Teddington and employing more than 2,000 workers. During the 46 years of its existence it has gained a world-wide reputation for its scientific research on a wide range of subjects.

The purposes for which the National Physical Laboratory was founded were "to bring scientific knowledge to bear practically on Britain's everyday industrial and commercial life; to break down the barrier between theory and practice; to effect a union between science and commerce." These are the prime duties of the Department of Scientific and Industrial Research as a whole, and so it was natural that the laboratory should become one of the ten major research stations controlled by the Department.

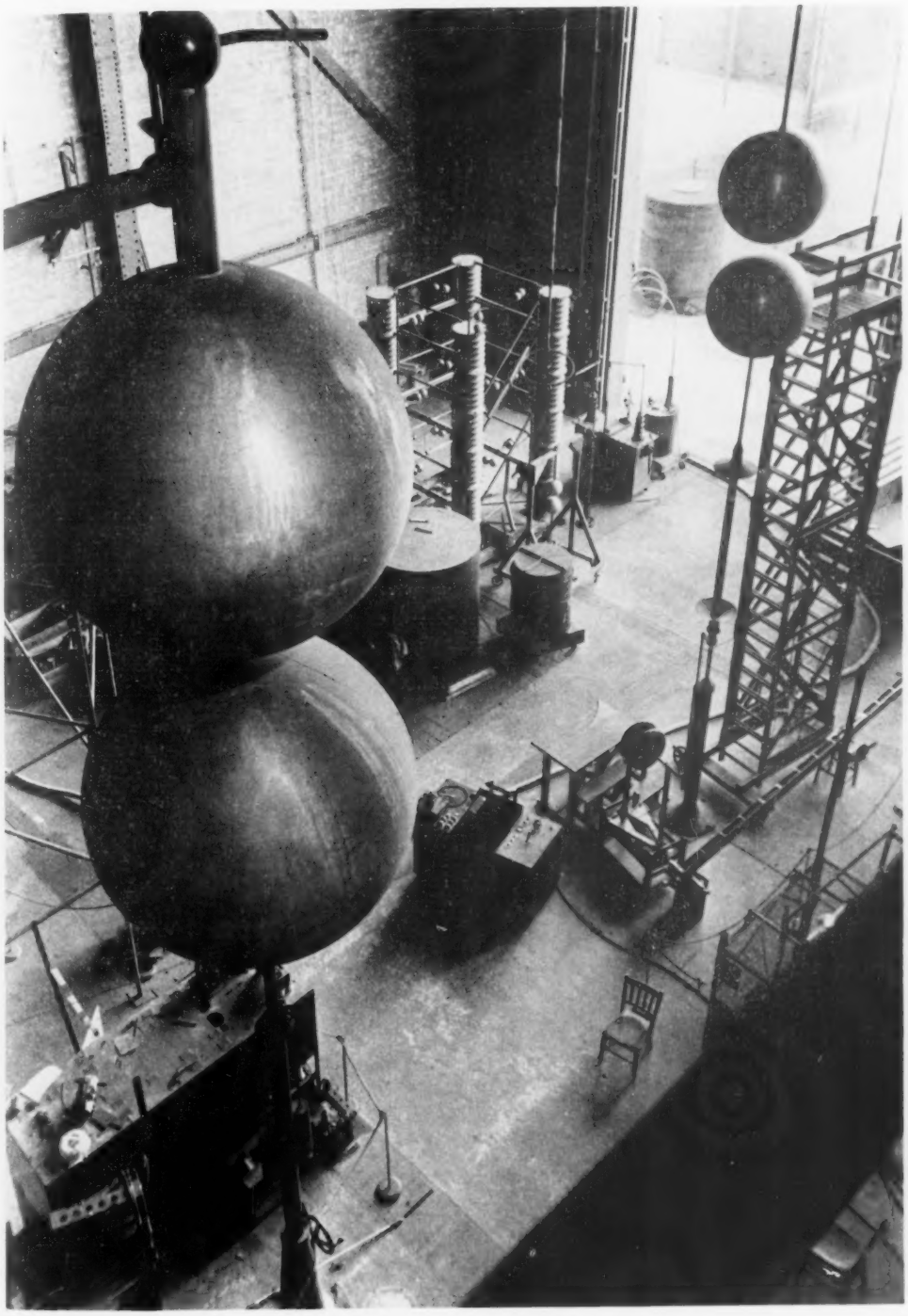
The director of the laboratory is always a scientist of international standing, selected by the Royal Society and the Department in consultation. At present it is Sir Charles Darwin, a grandson of the famous biologist of the same name. As a soldier in the war of 1914–18, he was awarded the Military Cross.

The progress of modern industry depends on an ever-increasing accuracy of measurement. No single industry, far less any single firm, can undertake the determination of the numberless standards and physical constants required in industrial processes. It is a form of research that can only be undertaken by a national organization, and in Great Britain this is the primary work of the National Physical Laboratory.

The Laboratory is responsible for the maintenance of the national standards of length, time, and mass, the temperature scale, and of various electrical standards. The accurate determination of the physical constants of materials and the study of the properties of engineering materials and equipment are also the responsibility of the National Physical Laboratory. Tests and calibrations of apparatus such as volumetric glassware, clocks and watches, thermometers of all types, optical instruments and so on are carried out, and a considerable volume of research is done for other government departments and research organizations and also for industry.

The National Physical Laboratory is organized in ten divisions, dealing with physics, engineering, electricity, radio, metrology, metallurgy, light, aerodynamics, ship design, and mathematics. In the short space of this article it is impossible to cover all the work of all the divisions; almost every branch of science is embraced and the scope of the research carried out is very wide.

Since the work of the Laboratory involves precise measurement, a considerable amount of research is made into methods of measurement. The Metrology Division is responsible for the maintenance of the primary standards of length, mass, and time and for their derivatives such as volume, density, and pressure. The Division insures that agreement is maintained between its own metric standards and those of the International Bureau of Weights and Measures. Measurements accurate to one-millionth of an inch can be made, and these were of value during the war of 1939–45 when a large amount of precision testing of engineering gauges was carried out for industry.



HIGH VOLTAGE LABORATORY

A GENERAL VIEW OF HIGH VOLTAGE EQUIPMENT AT THE BRITISH NATIONAL PHYSICAL LABORATORY.

The Metrology Division, however, is not the only part of the Laboratory concerned with precise measurement. The Electricity Division, for instance, has a section dealing

with the realization of the primary international and the centimeter-gram-second units of current, voltage, and resistance. It is responsible for the maintenance of these standards and also of radio standards. For this latter work a multivibrator wavemeter with quartz crystal control has been developed; its accuracy and constancy are such that frequency comparisons can be made to within one part in ten million. The Acoustics Section of the Physics Division has done much research work on the measurement of noise, and the Radiology Section of the same Division has charge of the British radium standard. Nearly a quarter of the world's estimated pre-1939 supply of radium has been measured in this section.

And so it is throughout the National Physical Laboratory. Maintenance of standards of measurement is one of the primary tasks, but that is only a portion of the work. The study of the properties of materials is of equal importance, and most of the divisions are concerned in this work. As an example, the Engineering Division has done much research on the causes and conditions of failure of materials, commonly known as "fatigue;" it has also done the pioneer work on "creep," the flow which occurs when metals at high temperatures are subject to forces of various types. The primary work of the Metallurgy Division is research into the physical and mechanical properties of metals and alloys, their constitution, and structure.

Most of the divisions do research which has a general application to industry as a whole, but two deal almost entirely with specific industries. The Ship Design Division carries out experiments on models, with the object of improvement of ship design and propulsion. Before the 1939–45 war more than 80 percent of new British mercantile ship construction was only begun when model tests had been completed in the Division. The resulting economies in fuel for ship propulsion have saved the shipping industry at least a million pounds a year. For the construction of the Mulberry Harbors for the invasion of France, the Division carried out experimental work necessary to decide on methods of construction.

The Radio Division carries out the research program of the Radio Research Board of the Department, and this program includes the fundamental study of the propagation of radio waves. This has involved extensive research into such problems as radio direction-finding, fading, atmospherics, and the physical properties of the ionosphere. To a large extent the British success in radio-location, or radar, as it is better known, before and during the war of 1939–45 was due to research on the ionosphere, carried out on behalf of the Radio Research Board.

Mathematics has become increasingly harnessed to the needs of government, industry, and research. Often problems are encountered whose solutions are extremely complicated. When a formula has been found, it becomes necessary to compute the value of the formula for all likely values of the variables or to invent a mechanism which, on being set in accordance with these values, automatically and mechanically produces the answer. The Mathematics Division undertakes research into new computing methods and machines and acts as consultant on mathematical matters to both the British Government and British industry. It is organized in three sections, dealing with computing, statistics, and the development of calculating machines. Its interest is wide, and the officer in charge is an expert on quality control in industry. Thus the new Division maintains the tradition of the Laboratory of keeping in touch with the needs of industry as well as modern developments in science.

OLD AGE: MINUS AND PLUS*

By GEORGE LAWTON

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MOST of us are so afraid of old age and so hostile toward it we assume "aging" means decline and that "change with age" is another way of saying "loss."

It may be hard to believe sometimes, but there are "plus" changes with age. We all know that a loss of one sense compels the other four to do the work of the missing one. In the same way, as we grow older, *the loss in one capacity may be precisely what makes the gain in another possible.* It is only after the departure of certain youthful pleasures that particular pleasures of later maturity can arrive.

But we must be prepared to exploit all these gains to the fullest. And we must also try to find compensations, substitute and indirect satisfactions, for the unavoidable "minus" changes which the years bring.

Let us assume you were normal mentally and emotionally in your youth—a big assumption—and that you are growing older with the usual quota of physical ills and financial reverses. But thus far you have managed to steer clear of catastrophe. What normal losses and normal gains may you expect?

It was Shakespeare in *As You Like It* who gave us a classic version of what it is to grow old. But we all know this by heart. I prefer to quote Shakespeare in an unusual translation made by Commander Alan McCracken, U. S. N., during the thirty-three months he spent in three different Japanese camps in the Philippines. Commander McCracken prefaces his translation with this explanation:

> [This] passage . . . I translated into Chinese ideographs while at a Cabanatuan Prison Camp. The ideographs, translated back into English, read:
>
> All the world a stage and all men
> and women mere play actors
> Have exit, have entrance. One man
> during lifetime play on the stage many part
> Acts of play designated Seven Ages
> First New-born Infant—wail loudly—
> vomiting inside wet nurse arms.
> Next Schoolboy—morning face shine—
> drag foot toward schoolhouse—imitate snail.
> Next Lover—sighing resemble furnace—
> compose poetry dedicated beautiful woman
> eyebrows.
> Next Soldier—curse—quarrel—seek
> reputation's bubble inside cannon mouth.
> Next Judge—well-fed stomach grow fleshy—
> expression of eyes severe—
> mouth spout out wise saying.
> Sixth age, Declining years—spectacles
> above nose—stockings plenty oversize
> skin shrink—big strong man voice re-
> turn child's voice—thin whistle sound.
> Last act end this strange eventful history—
> Second childhood—teeth go—sight go—
> taste go—everything go.

After so charmingly quaint a description of the aging process, I am afraid what I have to say will seem like a letdown, however exhaustive it may be. We may also yearn to linger over the early maturity stages in Shakespeare's schedule. However, we have stern business ahead of us, and reader and author, after taking one last look over their shoulders, will have to turn to the "Judge" as he comes on life's stage.

What inexorable processes are working themselves out as the Judge disports himself? First, let us take those human abilities which are most apt to decline with time. Then, before we become too unhappy, we can turn to a twilight zone, one where the changes may seem a loss to some

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and a gain to others—depending on one's philosophy of life. Last, after wending our way through a Dantean Hell and Inferno, we will emerge into a true "Paradise" —unless we dropped out on the way—and contemplate the pure gains, the cloudless brilliance of the plus qualities.

Shakespeare speaks of the Judge's "severe expression." The Judge doesn't feel severe; he merely looks severe. One of the problems of age is that we feel one way but look the opposite. Shakespeare's observation underscores the fact that it is in appearance that we most notice the changes with age.

The second half of life might be considered one prolonged period of "dehydration." The body is less able to absorb and retain water, and the inner contraction of the tissues causes the surface muscles to buckle (wrinkle). Chemical deposits narrow the aperture of the blood vessels, and they grow more rigid. When that happens in the eyeball, and the almost inevitable farsightedness also is present, the look becomes more severe.

There are other changes. The hair on one's head thins out and what remains turns gray. Natural teeth may have to be replaced by the creations of the ceramic artist, today more beautiful than the originals. Vision and hearing grow less acute, and we resort to mechanical aids.

There is more to this sorry catalogue of cosmetic changes, but the reader will be glad to pass on to another familiar but less painful fact: the decrease in available energy and the way we have to cut down on the length of our working day, as well as to reduce the number of assignments we once could handle with dispatch.

Our muscles also begin to go back on us. Tasks on the job or in the home, once easy, now become monumental. The sports we formerly managed with skill and relish, we must drop. Our interest in them may also go, but if it continues, we are now in the audience. After a while, we are not even in the grandstand watching. We are in the overstuffed chair at home, listening.

Something else happens to the Judge. He finds his "reaction time" increasing, though he probably wouldn't call it that. In a mood of letting down his hair (?), he might admit he wasn't as quick on the pickup as he once was. His eyes and ears might still be good receivers of impressions, but it takes him longer to interpret and to respond to what they report. Even if he thinks as quickly as he ever did, the teamwork between eye and muscle is slower and less accurate than it used to be. The golf ball no longer responds to his subtlest wish as it did on those glorious afternoons of yesteryear.

But what if the golf course is no longer the scene of the Judge's major triumphs! He simply has transferred his athletic prowess to the dining table. Pleasures of the gut take the place of pleasures of the tennis court. And the trophy of his skill is the "fleshy stomach" of which Shakespeare wrote.

The Judge, if he can look at himself objectively, will note that his eyes and ears notice less of the world around them, which he is apt to attribute entirely to a slight worsening of his vision and hearing. But he also finds that he has to concentrate more, if he wants to fix impressions, and this becomes an awful chore for the Judge. He is apt to get irritable and blame the external impressions for this increased need to concentrate on them, not realizing that he has become more inward turned with the years and is beginning to think more of the past than he does of the future. The search for alibis may become his favorite mental exercise and regret his most popular hobby.

What with the Judge's physical and emotional decline, the outside world begins to seem faded and trival to him, though it teems with excitement and challenge, as it always has to one who happens to be young and happy or to an older person actively a

part of the present. Remembering new facts becomes more difficult in later maturity because the brain is like the wax surface of a phonograph disc which has hardened and no longer takes fresh impressions easily. It is no wonder then that the Judge finds it hard to ***remember*** what he has just seen or heard, though an even greater problem is to *see* or ***hear*** it in the first place.

Fatigue and, even more, the griping about it, is an obvious sign of decline with age. If you want a perfect setup for producing these signs, to a situation where concentration is necessary add speed as another requirement and include in the situation plenty of noise and hubbub.

All of us as we get older discover that we cannot pin-point our ideas with quite the same precision that we once did. If when younger we tended to miss the target in our talking and writing, we do it even more now.

There is a hoary but mistaken tradition that at the Judge stage and later, we talk *more*. What happens is that we talk the same amount but say less in the same number of words uttered in the same time. We are hitting all around the target and need more trials before we make a strike.

At twenty we live mostly in the present and partly in the future. At forty, past, present, and future receive about equal consideration. At sixty-five the thoughts and conversation of most of us tend to revolve about the past, with the present receiving a little attention, the future hardly any. Sentiment, nostalgia, loneliness, the search for the meaning of our life and of human existence in general—all make even normal older persons think more of the past. Generally it is remembered incorrectly. Idealization is the usual error: "the good old days;" less often, the past is "worsified" and made harsher than it actually was.

At sixty a man can expect on the average to live 14.73 years more; at eighty, 5.27 years; at one hundred, 1.37. No matter how long or short one's life expectancy, to be still interested in the possibilities of one's future is a major youthful trait that is always appropriate, because it is basic to the life process. Occasionally we see it in a person of eighty or ninety despite illness or infirmity. To lose interest in setting up personal goals, some distant, some near, and to give up the struggle for their achievement—this is to grow old, regardless of *when* it happens.

One of the best examples of wholesome perpetual youthfulness is Winston Churchill, who on his seventieth birthday was described thus: "He still remains a young man with a bright future." Bernard Baruch, during an interview in August 1945, told about his uncle, who decided to retire and sold his business, but, seeing it do so badly in the hands of others, he bought it back at eighty-seven. At ninety-nine he had tripled his assets. The last sentence of Charles Hanson Towne's autobiography, *So Far, So Good* (1945), is the eager reflection: "I wonder what will happen tomorrow."

Emerson said, "We don't count a man's years until he has nothing else to count." The older person has a shorter future, it is true, than a young one. That is why Jean Paul Richert maintained: "What makes old age so sad, is not that our joys but our hopes cease." However, while the young person can expect a long future, he has a shorter past to learn from and less skill in extracting lessons from it.

The Judge indulges in more self-analysis and self-scrutiny than the "Soldier" or "Lover," though not more than the "Schoolboy." What makes him seem more inward turned than even in adolescence is the change in the reason for self-analysis. The young person seeks additional knowledge of himself in order to increase his working efficiency or to establish smoother and happier relationships with people. But those men and women we call "old" reflect on themselves in treadmill fashion,

for they lack all desire or hope to improve their abilities or adjustments.

What aids and abets this tendency to purposeless self-scrutiny is the preference for passive, spectator roles and activities, often not a matter of choice what with the lessened energies and physical handicaps which accompany aging. We must remember, however, that "spectatoritis" is a common disease of Americans. Our country makes it easy to grow old, except on the farm and in the small community, for these provide more purposeful activities for older people than the city.

Our Judge, beset by diminishing physical energies, reduces all his voyages of discovery. More and more he succumbs to the seductive allure of the familiar and the routine. Such experiences are snug and easy and, while perhaps dull, are safe. New experiences, however, though they may be adventurous and full of zip and go, also involve thinking, physical effort, and risk. Caution and comfort become rallying cries as the old man races off to do battle but without leaving his easy chair. The older person wouldn't put it that way. He talks about "newfangled" methods or "foolhardy" experiences.

It is almost inevitable that as we prefer the armchair and rocker to an active and aggressive role in the community, we should devote ourselves to collecting things. Instead of going to the world or giving ourselves to it, we try to bring the world to us and hold it close where we can see it and examine it at our leisure. That is why at the Judge phase we are so passionately devoted to the collection of money, furniture, and honors. The hoarder, the miser, and the string-and-paper-bag collector are merely extreme examples of this "second-childhood" tendency, the old person and the young child both collecting for the same reason, however much the objects of their affections may differ.

Just as the Judge is not aware of the relationship between the decline in doing and experiencing and the interest in collecting things, so he does not see how withdrawal is making him a zealous defender of what he already knows and possesses instead of an acquirer of new facts and skills. He is a knight in shining armor defending a personal *status quo*. To scramble metaphors centuries apart, the Judge sets up an electronic eye which automatically warns him that a new idea has come near and a grave danger faces all he holds most dear and sacred, i.e., familiar.

An Arctic explorer always took with him an ancient and repulsive crone because the evening he found her rather attractive and appealing he knew it was time to pack for home. Every aging executive or professional man should see a similar warning significance in his exclamation:

> I've been in this field for thirty years. But I'll be damned if I'm not more and more convinced every day that the young fellows now coming into this business have the strangest and wildest ideas. What is the world coming to! Why, when I started out. . .

That speech is a signal to the speaker that he either should turn his job over to others or else submit to old-age rehabilitation.

Some old people may be feeble physically, but there is no battle they fight with such fierce, protracted, and bitter enthusiasm as when they resist a change in their daily routine or usual approach to a particular problem. The index file must have a red sticker on the left side and a blue one on the right—until the end of time. Toast has to have a certain spongelike softness, and the egg must lie on it exactly so, and woe be unto him who forgets it. Tea must have one and a half sugars, no more or less; dinner must be served at 6:15; the time for a walk is Sunday between 2:00 and 3:00.

When an old person indicts an idea on the ground of its newness, whether it be in business or private life, he is merely proving that with age there is an increase in rigidity of thinking. Old people are fond of com-

plaining of their poor memory, the way they forget names, or their stupidity in arithmetic. Actually, these are minor personal inconveniences, regarded with affection, not regret. The older person's loss in emotional and mental flexibility, however, is of major personal and social consequence.

Rigidity has its physical and psychological causes. But most older men and women are not interested in any system of rehabilitation or re-education which might make them more flexible. What they are afraid of is not the impossibility, but the possibility, of change. After all, most of us feel age should have some compensations, one of which is freedom from ever having to exchange any of our old ideas or habits for new ones.

In early maturity, there is a great surge toward socializing and good-fellowship which is part of the sex drive and the search for a mate. As this drive and search lessens, so does our fraternizing impulse. In later maturity, there is a less urgent need for the emotional release afforded by confession. Nor do we need friends, as we did in our youth, to help us verbalize our thoughts and feelings and thereby understand them.

In old age, our increased enjoyment of solitary experiences is another example of second childhood. In youth, we have not yet taken our place on the stage; in old age, we have stepped off and are leaving it farther behind each day. In both instances, the external world of major struggle and change is a far distant performance.

If we live long enough, we exchange the Judge phase for the "thin-whistle-sound" stage. That is when we begin to lose the secondary sexual characteristics: the earlier masculinity or femininity of voice, complexion, walk. We become not merely a third sex, a merging of male and female, but a fourth, a kind of neuter gender, a part of the natural world, like an old tree. Here, too, there are exceptions, and we all know the old person who is still an old *woman* or an old *man*.

Just how much of a decline there is in sexual urge and ability with age is not easily learned, and for several reasons. First, we do know that older men and women vary more in their sex behavior than in perhaps any other kind. Second, in the case of women there is no objective test of ability to perform as in the case of men. Then, the sexual performance of a man is very much influenced by success or failure in his emotional and vocational life.

At the Judge stage, the human animal no longer is quite so driven to obtain sexual release of a purely physiological nature as at earlier stages. And in the thin-whistle-sound phase, there is apparently for most men another great reduction in urgency and a greater reduction in ability to perform. What scientific evidence we have shows that the decline in performance ability in physically and emotionally normal older persons is less than generally supposed.

If it is difficult to determine decline in sexual urgency and ability with age, it is even more difficult to chart the actual degree of decrease or increase in *interest*, particularly in women. The attitude of older men and women toward their sexual lives is more dominated by convention than is their attitude toward other matters. The little we do know shows hardly any decrease in interest. But we do see a great decrease in the expression of this interest.

THE "DOUBTFUL" GAINS WITH AGING

Shakespeare's Seven Stages represent a straight ascent to the peak of adulthood and a straight decline. About the last stages we read with melancholy and reach the "sans-everything" description with a feeling of dismay mixed with inverted gratitude: "Thank God, I'll never be that way. I'll be gone long before."

The picture, however, is not so black. Shakespeare omitted all the asset aspects of aging, and they do exist. This is no mere

whistling in the dark. If a man or woman was well adjusted when young and encounters few external major reverses in later maturity, he will decline in some respects, it is true. But in other ways he has improved on his earlier achievements, particularly those of a mental, emotional, and social kind. Among such gains, however, are some which a few persons might deem losses. A scientific student of human behavior cannot arbitrarily decide the issue, since the side of the ledger on which we place these changes depends on one's "value-judgment," or point of view.

Suppose we rewrite Shakespeare, then, and insert subdivisions in the later stages. What do we get? Our very first doubtful change is the matter of decline in sexual urge and ability which we have already listed under losses.

Schopenhauer said he was grateful to old age because it had brought release from a monster tyrant: sex. Some persons might consider this escape from sexual tension as one of the plus aspects of old age.

We must note that with the passage of time we tend to become critics. We assay the past and foretell the future. This is the fact—but is it a gain or another decline?

We might apply the same question to the way in later maturity we seek the significance of our earthly span. The time par excellence for speculation on the possibility and nature of another existence is when our earthly one is drawing to an end with the speed of a rocket plane.

As we stand poised on our jumping-off place, we grow concerned with our position in history. That isn't so bad. But when we believe the problem should be equally crucial to others, particularly the younger generation, we can become an awful bore. Nothing daunted, we busy ourselves making sure that in our passage from *Who's Who* to *Who Was Who* (fortunately only our survivors see this last), due credit be given all our achievements. Posterity becomes a person, and with affection and a tear for ourself, we visualize "posterity" passing by a big handsome stone edifice with the magnificently lettered: "Dedicated to the Memory of John A. Doe, a great and noble soul." There are days of anxious indecision as we try to decide whether it is to be a monument, memorial, or mausoleum. A pleasure known to the aged and totally alien to the normal young is the loving and craftsmanlike joy of working over one's epitaph.

All of us have observed how our sense of time's passing depends on our mental state. When we are depressed and inactive, a day is endless; at a gay party, an evening is but a few minutes. When we are fearful of what the morrow will bring, the hours fly; when it holds nothing, the hours crawl. Albert Einstein, founder of the relativity theory, explained duration technically when he pointed out that to a man with a pretty girl on his lap, one minute was preposterously brief, but to a man sitting on a hot stove, one minute was an eternity.

Biological time, the rate of cellular repair and reproduction, as P. Leconte de Nouy points out, flows more slowly with advancing years. Wounds take longer to heal and fractures to mend.

But physical time, "clock time," goes faster the longer we live. De Nouy observes: "Young and old united in the same space live in a separate universe where the value of time is radically different." That is the fact. But how shall we interpret it—gain or loss? The explanation, of course, is that to a child of ten, one year represents one-tenth of his total experiences; to a man of seventy, one year is one-seventieth of his life and so only a fragment, gone a moment after its arrival.

THE PURE "PLUS" CHANGES WITH AGING

We now come to Shakespeare's most serious omissions. For besides the out-and-out declines and the doubtful gains, the *normal* person, aging *normally*, un-

dergoes changes which are definitely plus.

The older person, because he has lived long, has had varied experiences, each one repeated. Even Mrs. Judson, with an I. Q. below average, is forced to develop a little insight and is able to perceive a few relationships and connections she had not recognized before. Youth, no matter what its other virtues, and it has many, cannot have had a rich and diverse experience, just as it cannot in the nature of things have such possessions as old friendship.

Because of the variety and the repetition of our experiences and our memory of many trial-and-error experiments in living, the strategy of tackling problems often improves with age. This is what we mean by the improvement in judgment. Whenever it is important to know tactics, the many ways of gaining a given goal, then it is that the older person is valued. Our Judge, the older doctor, the craftsman, the political leader, the statesman, the artist in living—each can more than hold his own in meeting competition in his particular field.

That the Judge was developing more insight, Shakespeare did not show. Nor did he tell that the Judge also was devoting less time and energy to the struggle to make money, support a family, and obtain sexual satisfaction. As his voice turned more and more soprano-like, the Judge ate and slept less and was less interested in doing and possessing. The material world was no longer his oyster. Willy-nilly, at the Judge phase we start becoming a little more spiritual whether we like it or not.

Along with this change, there comes another which is yet one more way in which we enter a second childhood. In old age, we can devote ourselves to activities independent of rewards and become artists and contemplators. We like things for their own sake and are able to enjoy what we are doing while we are doing it. We no longer think only of results but can also enjoy the process by which they are achieved.

There is another reward for living long, one which makes the middle-aged look forward to old age. At last, we can do much of what we have always wanted to do. This may represent interests of youth, reluctantly abandoned, or brand-new choices.

This wonderful sense of freedom to choose entirely on the basis of what *we* want is possible mainly because of a long experience with our likes and dislikes. Also, we have more free time and free interest because we no longer devote most of our days and evenings to money-making, career-building, or love-making—whether in prospect or retrospect. Finally, our reduced energies and slower tempo of activities force us to focus on what deserves top priority in our lives. The hourglass is running low, and it is imperative that we enjoy the activities and experiences most important to us and scrap the minor ones. "When the half-gods go, the Gods arrive."

There is one major plus quality to old age, so important that Shakespeare used it to embrace most of middle and old age, and we have therefore been using it as a kind of theme song. This is the so-called judicial characteristic. We become more objective in our approach to problems. This is due only partly to experience; it is a by-product also of a decreased personal stake in the result of our judgment, reduced biological "drives," and fewer personal ambitions. The fires of the emotional life have been banked but not extinguished, and we can stop longer to think. Here again we see how a gain with age is made possible by the loss of some youthful characteristic.

One of the great possible gains with later maturity is the increase in self-acceptance. By that time we know our strengths and our weaknesses and no longer are dismayed or confused by what we are, though that does not necessarily

mean we approve of our weaknesses or stop trying to eradicate them.

That is why a "serene old age" is a misleading phrase. It seems to argue a passive acceptance and resignation. In later maturity we are more conscious of the difference between inner conflicts and outer ones. We do not mistake one for the other. The so-called serenity of old age is not a meekness; it is a calm knowledge of priorities, a gathering of energy to fight one's major battles.

Another great plus change with old age is the desire to be of service to others, owing partly to the decline in personal ambition, partly to a desire to gain the present friendship and future good opinion of that posterity whose recollection of us we sometimes feel may be the only kind of immortality we shall ever enjoy. But part of the altruistic impulse in older people is pure disinterested benevolence. In old age, many of us want to be kind and good simply because we want to be kind and good. It is the only outlet we have for our tender impulses and parental protective feelings.

The absence of socially approved outlets for our good impulses may do us as much harm as the lack of similar outlets for our hostile, destructive, and sensual impulses, our so-called sinful and evil sides. The apparent cantankerousness of some older people stems from their having no vehicle of social expression for their do-good impulses. They are also thwarted by the lack of recent practice in group participation after a long period of being family-centered or self-centered.

One of the finest gains we associate with old age is the development of perspective, the capacity for seeing vistas, a prime ingredient in wisdom. We are able to synthesize and correlate varied units of our experience and our formal knowledge. In the apt words of Virgilius Ferm:

> A person is said to have wisdom when he is able successfully to peer beneath or beyond the superficial and seemingly self-evident, to see subtle relationships, and when he knows how to coordinate seemingly isolated items and view them in their true perspective and to bring this insight to bear upon the problems and tasks which confront him. A man may have much knowledge and not be wise; however, he could hardly be wise without adequate knowledge. Wisdom is more than information; it is information crowned with understanding (*First Adventures in Philosophy*).

So much for the losses and gains with age. Perhaps even at best there still seem to be more minus quantities than plus. Even if numerically equal, some persons may feel that all the plus qualities of age fail to compensate for the loss of a single important youthful characteristic—boundless energy, or freedom of physical movement, or attractiveness, or sexual potency.

Faust, we know, sold his soul to the devil so that he might obtain the magical reversal of one major decline. The plus characteristics of old age were ashes in his mouth. But Faust, for all his lore, was a maladjusted old man, as he had been a maladjusted young one.

Grow old all of us must. One goal for us when middle-aged is to postpone and, if possible, reverse the declines which accompany aging. But we have a much more important goal. We must also anticipate the plus changes of age (not youth) which are on their way. And we must exploit these gains to the fullest when they arrive. Then we all will say, as a seventy-year-old woman recently wrote to me: "I need no adjustment to old age. The last ten years have been the happiest of my life."

A PHYSICIST LOOKS AT MORALITY

By ROBERT A. McCONNELL

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IT IS a matter of principle in science that one should not hesitate to state the terms of a problem even though no possibility of its solution has been envisaged. To have understood a dilemma is often to have taken the first step toward its resolution.

It is with this in mind that the writer examines the rational basis for morality and finds it wanting. He disclaims pretension that his brief exposition can add significantly to so massive and profound a subject.

It appears to the writer that the probability of atomic war within two decades can be conservatively stated to exceed one-half. In an age of technologically possible plenty and technologically unlimited destruction such a war will be without economic justification. Its occurrence must be blamed rather upon the failure of man's will-to-peace. Its avoidance will be only through assertion of the supremacy of man's spirit.

To this end, it is the need of our time that man should achieve a moral rebirth. Upon this need our many leaders are agreed. The professional guardians of men's souls cry out: "Only religion can save the world." The nationalistic demand that America rise to meet her destiny. Our intellectuals call upon democracy to capture to its ideals that spiritual devotion which Nazism evoked in Germany.

These dicta sound a common truth: Man must conquer himself even as he conquers his environment. Alas, they also sound a common note of helplessness. Our leaders stand without authority, like mariners in front of empty sails whistling for the wind.

With what arguments are we told to reform our ways of life? The proponents of religion offer dogmatic morality, clothed usually in the trappings of ancient superstition. Some vigorous philosophers in the spirit of our industrial culture reject the forms of religion, proclaiming instead an animistic and frankly intuitive moral code. A third group appeals to reason, ignoring the gaps where reason fails or filling in with metaphysical logic of a religious nature.

Let us pass over religion and intuition. Let us examine reason as a basis for morality. How much does reason tell us? Starting with assumptions universally acceptable to thinking man as to the value of life, it will be agreed that one can deduce the validity of the principle of common effort, the principle that man should help man. This leads directly to most of the Ten Commandments: Thou shalt not kill... Thou shalt not steal. . . .These are the rules by which society preserves itself. The learnedly materialistic insist that these are the whole of morality: that all acts, all values which cannot be measured in terms of man's welfare are amoral. But is this so?

A simple illustration may raise some doubt. Is it moral for a man to take his own life? One may assume that by suitable collateral conditions the question is removed from judgment as a matter of common welfare. A completely detached observer would then still hesitate to say that this is not a moral question. Yet there is in the field of demonstrable knowledge no basis upon which to answer it.

The issues at stake go far beyond the trivial question of suicide. One may ask in general: Is the end the only justification for the means? Or is there an absolute moral code to which we must adhere: is there an end of which we are unaware? It is no answer to say that evil means must

almost inevitably lead to an evil end when the end result is considered in its totality. One may all too easily find cases where the probability of evident good would by every reasonable standard outweigh the probability of knowable evil. Is there an answer? What sophisticated seeker after truth can say that he knows?

Or still again, that most vital question of our time: What is the proper relationship of man to state? How highly shall we prize individual freedom at the expense of collective welfare? Does the collective good transcend every right of the individual? Or must government seek that more difficult path toward the millennium by which it will not trespass upon the fundamental liberties of each of us? We answer this question, as indeed we must, forcefully and without hesitation. Yet we *could* answer it either way. This may be the ideological question over which the coming war will be fought. Do we know the right answer? Is there any basis for a right answer in the same sense in which we can approve of the principle of common effort? Is not our knowledge of man's relationship to the cosmos therefore seriously defective?

In view of these moral uncertainties, is it surprising that common man is slow to respond to sermonizing? His leaders do not agree among themselves. Moral science, unlike the physical, has been forced to answer questions while lacking basic knowledge upon which to formulate a reasoned answer. Can man be blamed if he chooses to assume that all wisdom is contained within these two quatrains?

> Myself when young did eagerly frequent
> Doctor and Saint, and heard great argument
> About it and about: but evermore
> Came out by the same door where in I went.
>
> A Book of Verses underneath the Bough
> A Jug of Wine, a Loaf of Bread—and Thou
> Beside me singing in the Wilderness—
> Oh, Wilderness were Paradise enow!

This represents one possible point of view. Suppose instead, however, that we boldly try to follow reason to its end as though unfettered by our finite humanity. Shall not we then conclude: If war is to be banished between nations, if civilization is to advance without retrogression, we must find that key which will establish the whole of morality upon a rational basis?

HENRY ADAMS AND THE REPUDIATION OF SCIENCE

By CHARLES I. GLICKSBERG

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AT THE very start of his career, Henry Adams had discovered, as the result of his reading of Lyell and Comte, that man was not exempt from the laws which governed nature. It was a momentous intellectual discovery. On the basis of this insight, Henry Adams sought to determine the relation of man to nature and of nature to man. Gradually he came to the conclusion that the concept of order in the universe was a man-made fiction which received no substantiation from the chaos that ruled nature. The course of history revealed incessant conflict, internecine wars, restless and unpredictable change. There was but one golden period when the dream of spiritual unity was fulfilled: the twelfth century. Then the Mother of God held supreme sway over the hearts of men and canalized all their energy, all their capacity for faith. At last men were devoted with single-minded zeal to a religious ideal, and the evidence of their absolute faith was everywhere to be found in architecture, manuscripts, statuary, stained-glass windows. The study and interpretation of that century in its relation to the modern age of scientific skepticism became Adams' consecrated task.

Though he had speculated boldly on the possibility of establishing a science of history, his attitude toward science underwent a profound transformation; initial skepticism toward the scientific synthesis was replaced by a definite feeling of antagonism. The Middle Ages proved more fascinating and more worthy of allegiance than the God of the Dynamo. St. Thomas Aquinas, he concluded, was a better guide to life than Karl Pearson. The Thomistic philosophy exemplified unity on a grand scale; the modern world marked the enthronement of anarchy. Science, though it could confer on man the power to control nature, could not give him the blessing of faith.

Early in life Henry Adams' imagination had been quickened by listening to the lecture that Agassiz delivered on the glacial period and paleontology. But he was more excited by the theory of evolution, which drew him like a magnet. True, he had to take the atomic theory and Darwin's Law of Natural Selection on trust for he was not in a position to verify them, but they seemed to lead to some generalization which would make everything clear. If he could not understand Darwinism in all its implications, he might at least gain some valuable clues by plunging into the study of geology, where he might find proof to confirm the theory of evolution. He read the *Antiquity of Man*, by Sir Charles Lyell, and also his *Principles of Geology*. Here was an impressive statement of unbroken evolution, demolishing once for all the foundations of religion. He risked the venture of reviewing Sir Charles Lyell's book—his first connection, in print, with the world of science.

This exploration, however, led to difficulties. Was it defensible, he wondered, to assume uniformity from the start? The law of evolution often broke down, and it did not illustrate the principle of natural selection. Was the theory that Lyell advanced more than pure inference? All Henry Adams could detect was the process of change. The evidence supporting the doctrine of evolution was far from conclusive. Evolution did not seem to evolve; the uniformity that was postulated was by no means uniform; the work of selection was not selective. Though Adams wished to believe in the new doctrine, which other Darwinians accepted as a religious dogma,

he found on examination that he had no faith in it. Darwinism could not hold him. Even scientific faith was alien to him, and he outdid the scientists in his stubborn questioning of facts and theories. A skeptic at heart, he tried to make out that at the time he was a Darwinian for fun! The fun, however, could not hide his fear at the consequences that might flow from the scientific revolution. Was it not possible that, though man had mounted science, the steed might run away with the rider?

> I firmly believe [he wrote on April 11, 1862] that before many centuries more, science will be the master of man. The engines he will have invented will be beyond his strength to control. Some day science may have the existence of mankind in its power, and the human race commit suicide by blowing up the world.

As events have proved, this was by no means a fantastic conjecture.

Henry Adams was no scientist. It is doubtful whether he ever visited a laboratory or, during his stay at Harvard as Professor of History, ever fraternized with members of the science department. It is certain that, with the exception of his interest in geologic formations (while in the South Sea Islands, he made observations of coral beds as a check on Darwin's theory), he never performed any experiment that called for exact observation or the use of technical instruments. For facts as such he professed unmitigated contempt. He was interested primarily in the philosophy of science, the ultimate cosmic conclusions to which science could lead. In short, he was an armchair, or philosophical, scientist.

His growing disenchantment with the scientific method, once he grasped its inevitable limitations, was to be expected. One who thirsted for the Absolute could not rest satisfied for long with Positivism or Pragmatism. The meaning he sought to win could come only from unconditional faith, and here science was powerless to help him. All it could give him was the foundation of facts and a hypothesis by means of which to interpret them. Science, Henry Adams concluded, was but an illusion, less satisfying by far than other illusions that men once entertained in the bitterness of their need. If one had to choose, the symbol of the Virgin was infinitely more consoling than the symbol of the Dynamo.

There was a conflict in Henry Adams' soul between the artist and the scientist. The scientific discipline was too intellectual and too impersonal to supply him with the certitude of absolute faith for which he yearned. Though he might strive for plenary faith, religious absolutism was forever beyond his reach; he could not possibly recapture the religious experience except vicariously as he sat in the immense vaulted cathedral at Chartres and gazed in a kind of mesmeric trance at the marvelous stained-glass windows, beholding in his mind's eye the innumerable pilgrims who had knelt on these floors, the multitudes of sinners and sufferers that had come to the all-compassionate, all-forgiving Virgin, Mother of Sorrows, for help and healing. It was the aesthetic force of the religious experience embodied in the art of the Middle Ages that fired his imagination and stirred him to the depths.

He was the type of man who is dominated by the intellect and yet rebels against the tyranny of reason. As a historian he had a high respect for the accumulation of exact and thorough information, but that was not the primary aim of historical research, nor was scholarship in his eyes the aim and end of life. What he sought in the pursuit of history was the formulation of general principles arising out of past events and capable of fully explaining them. Just as a scientist draws up a theory which is a kind of postulational framework into which the observed facts fit, so Henry Adams, the would-be scientist of history, endeavored to discover a theory which would apply to all the known historical data and at the

same time account for the baffling phenomenon of change.

Throughout his life he sought understanding and he sought it in the only way a member of the Adams clan could seek it—through the disciplined faculty of reason. One had to depend on that in the last analysis or else everything proved a quicksand of uncertainty. This predominance of intellectual over emotional strength was bound to have its consequences, not so unfortunate as in the case of Charles Darwin or John Stuart Mill but equally marked. After the death of his wife, his skepticism became an inveterate mental habit. He retired more and more within his own shell, and his emotional nature had nothing to feed on.

THERE is a secret associated with his novel *Esther*, published anonymously in 1884. Why did this book mean so much to him in later years? With the exception of *Mont-Saint-Michel and Chartres*, there is no other book that he speaks of so highly. Why? We are forced to the conclusion that it had for him a special personal significance. The novel is much more than a story; it supports a thesis. Henry Adams intellectualized everything he touched, and this novel, like *Democracy*, is no exception. It shadows forth the ideas and convictions that were later to find expression in *Mont-Saint-Michel and Chartres*. First of all, it is a noble tribute to the nature of woman—intuitive, emotional, of sensibility all-compact—who arrives at truth in her own mysterious way. Second, it gives utterance for the first time to his perception of the conflict between religion and science, intuition and reason, feeling and intellect, science and art. This problem, in which he was engrossed for a number of years, he never succeeded in solving to his own satisfaction.

In *Esther*, Henry Adams was seeking to resolve in imaginative terms the problem that tormented him all his life long. The search for a unified meaning ended in defeat—a defeat that he pretended to regard with irony, but it did not ease the ache or fill the inner void. The suicide of his wife intensified his longing to escape from himself and what seemed to him a purposeless existence, a life that had been a "failure." To live without having achieved inner harmony, a pattern of meaning—that is what he meant by failure. Perhaps the universe possessed no meaning that the human mind could grasp; perhaps the quest for intelligible cosmic explanations was an aberration. Skepticism was the refuge of the orphaned intellectuals of the nineteenth century looking without hope toward the twentieth century. Skepticism led inevitably to science; he could not escape its impact. But if the universe was devoid of all meaning, if all human aspirations and ideals were no more than illusions and the sole reality was but a flux of energy, then there was but one conclusion to draw: a wise man would select those illusions which brought the blessing of inner peace. Illusion for illusion, the worship of the Virgin was as reasonable a faith as the belief in the electron. The geologist in *Esther* declares: "Mystery for mystery, science beats religion hollow." Neither religion nor science is true, he announces. Even science begins by demanding faith in the incredible. Solemnly he assures Esther, who is passing through a mental crisis, "that the doctrine of the Trinity is not so difficult to accept for a working proposition as any one of the axioms of physics."

Henry Adams' pilgrimage may thus be viewed as a progression from intellectualism to the artistic outlook that encompasses all things, resolves all contradictions. Student of law and history and science, he had searched for a clue to the working of the universe, only to give up the quest in despair, but the failure is finally resolved in the synthesis of art. Henceforth, once this liberating vision

had been vouchsafed to him, he viewed all things—history, civilization, politics, religion—as a spectacle. If all things were compounded of illusion, then one illusion was fundamentally as good as another—perhaps even better. That is to say, those illusions were best which gave consolation, certitude, peace eternal.

When in 1893 he visited the Exposition in Chicago, he was startled by this display of mechanical power. Here was a break in the chain of causality, a gap in historical continuity, that baffled explanation. There was the dynamo which could generate infinite quantities of energy. Lingering long among the dynamos, Henry Adams was convinced they gave to history a new phase. Men who had no knowledge of science or technology had to come to terms with these monstrous forces.

If one could trust neither nature nor art, as Adams discovered after he set out on his travels, one was perforce driven back upon science. But the only certitude that was scientifically reliable was the field of statistics. Even here he was disappointed. The statistical method did not culminate in any terminus of faith. The equation grew to such a point of complexity that it was hopeless to try to solve it. Then came the journey to Caen, Coutances, and Mont-Saint-Michel, where at last he was able to find himself. The law he had depended on as a historian had proved futile. After admiring the cathedral at Chartres, Adams concluded that he had all along been following the wrong trail. When, in a broken spirit, he was prepared to admit that life had no meaning and that in any event it no longer mattered, he came to closer grips with his life-problem and undertook the study of the twelfth century.

Before he took the road to Chartres and abandoned the Dynamo for the Virgin, he had tried to formulate a science of history. This is dealt with challengingly in "The Tendency of History," sent to the American Historical Association on December 12, 1894. No matter how extensive its field of research, history must constantly seek a unifying principle. Adams hunted for some principle that would transform the multitudinous odds and ends of facts into a coherent system. Since science is predicated on a cause-and-effect assumption, any science of history, he declared, "must be absolute, like other sciences, and must fix with mathematical certainty the path which human society has to follow." Whatever the consequences that might follow, if science offered the sole avenue to truth, it must be accepted and taught.

The problem is carried a step further in "A Letter to American Teachers of History." The traditional Newtonian universe neither loses nor creates energy. To go the whole hog in science and assert that the energy expended in the course of historical development was identical with physicochemical energy—that was asking too much. It was Darwin who spilled the applecart—who made it imperative that in the future all phenomena, organic and inorganic, human and animal, be studied as a science. As Henry Adams is careful to point out, however, Darwin never sanctioned the doctrine that organization of increasing complexity was evolution *upward;* that evolution was in any sense the same thing as progress. The notion that the organisms which survive furnish an example of growth from "lower" to "higher" forms is a vulgar misinterpretation.

Opposed to the evolutionist, however, was the Degradationist brandishing the second law of thermodynamics like a bomb. Physicists, astronomers, and geologists predict the extinction of the world, while society blindly staggers on, unshaken in its faith that it is moving onward and upward toward perfection. What defense, if any, is the historian to put up against the assault of the physicist? If thought, reason, and will are electrocolloidal processes akin to mechanical energy, then the second law

rules supreme and must dominate the philosophy of history. Henry Adams perceived that matter is energy itself. If so, then from the point of view of physics there can be no exemption. Man as a natural force has no other function "except that of dissipating or degrading energy." Human beings have steadfastly rebelled against the dominion of scientific law but in the end they must yield. The teacher of history could not dispute the ground with the physicist. His only salvation lay in becoming a physicist himself and learning how to use experimental methods. "The Rule of Phase Applied to History" explicitly declares that "the future of Thought, and therefore of History, lies in the hands of the physicists, and that the future historian must seek his education in the world of mathematical physics. Nothing can be expected from further study along the old lines."

The revolutionary implications of this manifesto have not yet been given their due weight. Here was a member of the Brahmin caste, a littérateur and historian, a student of medieval architecture, arriving at the heretical conclusion that the future belongs to science. If society may be postulated as a current of thought, then it may be studied as we study gases and fluids in general. That is the substance of the theory. The object is to determine some definite change of direction in human thought. Unfortunately for the theory, there is no valid connection, as modern historians have indicated, between the laws of physics and those of history. Adams' attempt to base a science of history on the knowledge of physics has been upset by later explorations of the atomic structure. Henry Adams' desperate quest was foredoomed to failure. Analogies drawn from science could not be legitimately applied to the onward movement of history. Henry Adams grasped at a philosophy of history based on the second law of thermodynamics because it fitted in admirably with his pessimistic conception of modern civilization. Armed with the law of entropy, he could explode the anthropomorphic faith in the doctrine of progress. Society, like the sun and the nebular dust, was under the relentless sovereignty of this law; its energies would sink lower and lower until it reached a point of absolute extinction.

When this conclusion disappointed him, as it was bound to, Henry Adams turned to the Church as a valid substitute symbol for the machine age. As Henry Steele Commager points out in his essay on "Henry Adams" in *The Marcus W. Jernegan Essays in American Historiography*, his adoration of the Virgin was

> in part an emotional reaction, an act of faith; but Adams could not be satisfied with a reaction merely emotional; he had to rationalize his faith in the power and the grace of the Virgin. . . .He who had lived, passionately, the life of reason, who had inherited from generations of Adams' a reverent respect for reason, made this gesture of faith an exercise in historical logic.

What was the relation, Henry Adams asked himself, between the force of the Virgin, a psychological projection, and X-rays? Was the force of the Virgin as potent as X-rays? The work he beheld at the Louvre and at Chartres convinced him that the energy emanating from the Virgin exercised a more compelling sway over the minds and hearts of men than all the steam engines and dynamos mechanical power could put into operation. All the mechanical forces in the universe could not, like the Virgin, achieve the miracle of Chartres. It was the task of the historian, Henry Adams now felt, to trace the evolution of this spiritual energy.

In the effort to follow the track of this energy, Henry Adams was driven into the maze of scholastic science. He read Thomas Aquinas, Descartes, Montaigne, Pascal. In the search for truth he had to choose between God, who represented unity, and Satan, who stood for multiplicity.

All he had learned in the past was radically wrong; he would have to begin from scratch. The laws of science he had once accepted were now brought into question. Science could not demonstrate how chemical or mechanical energy could by a process of evolutionary change be transformed into thought. Henry Adams had traveled a great distance since the days when he had been a trusting disciple of Darwin and Lyell. It was about time to confess his distressing state of ignorance. Evolution was not salvation. Science had to be defied. He had to push further ahead, to penetrate the beyond. Of the two kinds of ignorance, that of science and that of the Virgin, he preferred the latter. It was more human, more reassuring, more universal. The twelfth century at least furnished the proof of unity, which Adams craved.

What science said might be true, but its truth, if accepted, implied an act of mental suicide. The taboo against questioning the sphinx of the unknowable was logically convincing, but the mind of man was subject to spells of unreason, to powerful impulses that could not be logically explained, as was evident in the incessant speculations about the universe, which were neither reasonable nor logical. If the unknowable were unknowable, would not man long ago have realized the futility of his efforts? The persistence and passion of the search were a priori indications that there was something there. Henry Adams failed to see that the alleged "ignorance" of science was a stimulus to further inquiry, not an invitation to abdicate the function of empirical reason. All he had gleaned from his extensive reading of science—Ostwald, Mach, Poincaré, and Pearson—was that it had finally demonstrated its ignorance.

HENRY ADAMS' importance lies not in the originality of his speculation but in the candor and courage with which he faced the major problems that troubled his age. His conclusions were untenable because his purpose, in his later years, was not to understand but to believe. He wished to pluck the heart out of the scientific mystery so that he might arrive at the finality of faith. His motives in pursuing the study of science were therefore "impure." His "education," in one sense, represents an aspiration to reach the infinite, a desire to know the unknowable. He was only too glad to yield himself to the Virgin. One thing was certain: he could not abandon the quest. In *The Education of Henry Adams*, he writes: "Every man with self-respect enough to become effective, if only as a machine, has had to account to himself somehow, and to invent a formula of his own for his universe, if the standard formulas failed."

Henry Adams stood helpless before the prodigious advance of science, incapable of judging the correctness of its conclusions, passing over what he could not understand but hopeful of catching a vital clue that would complete his education. His search was not an intellectual exercise but a cosmic quest, a hunger for salvation, for religious unity. Like Tolstoy, but without the latter's emotional intensity, he exhausted all the available explanations of the universe. Since science was the distinctive contribution of the nineteenth and twentieth centuries, he set himself earnestly to the task of mastering it. The twelfth century, however, was a blessed escape from the vertiginous dynamism of the twentieth. In the world of Thomas Aquinas he could feel at home. Science promised so much and yielded so little fruit. Darwin had led him astray. As far as he was concerned, the only book it had been worth writing was *Mont-Saint-Michel and Chartres.*

In this volume, Henry Adams wanted to show with what intensity the vital energy of that period expended itself in the highest forms of religion and art. Compared with that epoch, the present age, which had lost its primitive creative instinct, was decadent.

Regarding the triumphs of this age, he declares in his "Prayer to the Virgin of Chartres":

> Yet we have Gods, for even our strong nerve
> Falters before the Energy we own.
> Which shall be master? Which of us shall swerve?
> Which wear the fetters? Which shall wear the crown?

His "Prayer to the Dynamo" is a poem of a different order. It addresses the Dynamo as a "mysterious power," a "despotic master," a "tireless force." Either humanity or the dynamo must bend to bear "the martyr's cross." Whether it be matter or mind, the Dynamo is blind, deaf to prayer; and yet man continues to pray. There is no answer to the question that man asks. Only silence. All those who have taken this weary journey through the deserts and abysses of science will have no choice at the end but to come back to the Virgin and surrender to her grace and love.

The Middle Ages provided both escape and corrective. Throughout *Mont-Saint-Michel and Chartres*, it is the incandescent glow of faith that appeals to Adams, the feelings beautifully expressed in stone, arch, spire, glass, music, image, and verse. The writing of this book, which involved years of arduous yet ardent research, satisfied a profound personal need. The Virgin was the supreme miracle, and Adams gave up the effort to understand it by means of the unaided reason. Man has failed in his efforts to capture the secret of the absolute. Science now repudiates any attempt to smuggle philosophical essences into its investigations. The twelfth century at least strove to achieve the truth that God was the ultimate universal and that truth existed outside the mind of man. On ultimate issues, Haeckel and Farady and Clerk-Maxwell are as much in the dark as the theologians of the Middle Ages. There is this much to be said for Thomas Aquinas: he succeeded in fusing God and man, mind and matter, the universal and the individual, into a harmonious whole.

Henry Adams studied mysticism but never became a complete convert to mysticism; he studied science but never became a scientist. What science discovered in the behavior of atoms he attempted to apply to the behavior of human beings in society, but he soon saw that it was impossible to reduce either nature or society to order. That is an illusion rooted in the mind of man. It is a dream of knowledge that is repeatedly destroyed by the brute force of chaos, yet man clings to the dream. Like Karl Pearson, Henry Adams had argued that the laws of science are not true in an absolute sense; the forces of nature function without apparent purpose or direction: a violent illustration of anarchy in action. If the universe is nothing more than a loose bundle of anarchical energies, if purpose is an anthropomorphic illusion, it means that man's history, too, is a record of confusion and chaos.

In accordance with his theory of the dissipation of energy, Henry Adams came to regard reason as an enfeeblement of energy, being but a modification of primordial instinct. Instinct, not thought, is the source of vital energy. That is why he distrusted the thinking process and fought against his own overdeveloped intellectualism. It is this desperate denial of the significance of consciousness, reason, and science which led Henry Adams to compose his "Prayer to the Virgin of Chartres."

All those who turn to science with "impure," utopian expectations are sure to be disappointed. Science does not promise salvation to its devotees; the best it can give them is but a partial glimpse of the ever-elusive and bafflingly complex totality of truth. The struggle through which Henry Adams passed is of considerable significance because it portrays so poignantly the crises and conflicts of contemporary intellectuals. Today, as in Henry Adams' unhappy old age, it is

alleged that scientific thought illustrates a trend away from naturalism. There is an unmistakable emphasis on the importance of the irrational, and there are repeated efforts, with which Henry Adams would probably have strongly sympathized, to impose a "spiritual" interpretation on nature. Recent developments in the philosophy of science, notably the Heisenberg principle of uncertainty, are looked upon by a number of lay thinkers as confirming their intuitions concerning the nature of the universe. At last, like Adams after he knelt in prayer before the Virgin, they are free from the iron reign of determinism.

Unfortunately for these people, the development of modern physics offers no support for their consolatory conclusions. The principles of modern science do not lend themselves to such casuistic stretching. The *sine qua non* of physical theory is that for every term used we must provide a description of the physical operations by which it is to be tested. A scientific proposition has meaning only if it states the means for its verification. If these are not given, the statement belongs to the realm of metaphysics. Judged by this rigorous canon of operational validity, Henry Adams was a metaphysician rather than a scientific thinker.

In one respect and in one respect only does science support some of the contentions of Henry Adams, who was seeking a clue to the heart of the universe. Science is a postulational system. The law of causality, for example, is but the expression of a definition; it is therefore neither empirical nor a priori but part of a heuristic terminology. Theoretical science is thus essentially a work of the imagination, but from this it does not follow that it is irresponsible in its constructions. Pure science, declares Phillip Frank in *Between Physics and Philosophy*, "states nothing about empirical nature; it only gives directions for portraying nature." Henry Adams was right, too, in recognizing that science progresses by eliminating the anthropomorphic and the subjective. But then, asked Adams, how on such a basis explain the action of the mind if it must be interpreted in mechanistic terms? Put in this form, the problem appears insoluble. A mathematical world outlook seems to be more in tune with a philosophy that stresses the "spiritual" element in the structure of the universe. But properly understood there is actually nothing spiritualistic in twentieth-century physical science. The role of the psychic cannot be smuggled in with impunity. Nor can we take comfort of a metaphysical character from the theory of indeterminacy. The scientist simply asserts that truth, if it is to be accepted scientifically rather than metaphysically, exists only in its concrete embodiments. Our statements are true if there are valid methods of testing them.

What judgment, then, can science pass on *Mont-Saint-Michel and Chartres?* The way out of this dilemma is to bear in mind that language does not always perform a communicative function. It may be employed as a means of arousing feelings or attitudes. It may be suggestive, not logical and informative in character. In *Experience and Prediction*, Hans Reichenbach describes another function of language: the relaxive function. "Language may release us from an inner constraint, may slacken a tensed mind—be it the oppression caused by physical or psychical pains, or the delightful tension of joy, or the nervous constraint of productive situations of a creative mind." That was the function language performed for Henry Adams when he composed his "Prayer to the Virgin of Chartres" and his glorification in prose of the mystical power of the twelfth century.

Henry Adams touched the life of his time at many vital points and reacted with sensitive awareness to all its complex stresses and strains. He had to cope with two newly emerging "destructive" forces:

industrialism and science. It would have been comparatively easy for him to have played the game as the world plays it—to compromise, to make a god of expediency. His destiny was precisely this—to stand apart and suffer, to search for a "truth" difficult and impossibly out of reach. His pursuit of science was that of a gifted layman. He could not proceed far without feeling lost and damned. Since science left him high and dry, he turned to religion for the truth which saves. His overdeveloped skeptical intelligence, tired of the fruitless struggle, yearned for the absolutism of faith. All that science could give him was the promise of power; he preferred to take the road that led back to the Virgin, confident that others would, in the hour of disillusionment, follow his example. His confidence, however, was shaken again and again, and it was the frustration of his efforts to achieve a transcendent synthesis that would supplant the dominant philosophy of science which accounts in part for the fact that he persisted in looking upon his life as a "failure."

WAR ECHOES FROM LUCRETIUS

Man, the high of mind and proud of heart,
Is soonest fallen in the wake of force.
Mountains hold their scarred forms;
Flowers survive, and birds sing at the ruins.
But man, the monarch, fallen, melts—
To seep his humble way to dust inanimate.
A tale no sooner told than tells itself afresh
Nothingness alone fails feel the cosmic urge
To tread untiringly the upward way.
No clod of earth insentient but minds itself as man
And yearns and strains to mount anew the spiral steep.
Speck binds itself to speck, but darkly knowing,
To feel the flush of touch,
Viable with cosmic zest, clairvoyant of sentiency.
Nothing fails of return in Nature's rounds,
Though all is touched the while with sad impermanence.
The rose surmounts the mould and, unceasingly,
Life finds a darksome track through death
To light the earth with life—and life again.

T. V. Smith

THE PRINCIPLES OF POOR WRITING

By PAUL W. MERRILL

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BOOKS and articles on good writing are numerous, but where can you find sound, practical advice on how to write poorly? Poor writing is so common that every educated person ought to know something about it. Many scientists actually do write poorly, but they probably perform by ear without perceiving clearly how their results are achieved. An article on the principles of poor writing might help. The author considers himself well qualified to prepare such an article; he can write poorly without half trying.

The average student finds it surprisingly easy to acquire the usual tricks of poor writing. To do a consistently poor job, however, one must grasp a few essential principles:

I. Ignore the reader.
II. Be verbose, vague, and pompous.
III. Do not revise.

IGNORE THE READER

The world is divided into two great camps: yourself and others. A little obscurity or indirection in writing will keep the others at a safe distance; if they get close, they may see too much.

Write as if for a diary. Keep your mind on a direct course between yourself and the subject; don't think of the reader—he makes a bad triangle. This is fundamental. Constant and alert consideration of the probable reaction of the reader is a serious menace to poor writing; moreover, it requires mental effort. A logical argument is that if you write poorly enough, your readers will be too few to merit any attention whatever.

Ignore the reader wherever possible. If the proposed title, for example, means something to you, stop right there; think no further. If the title baffles or misleads the reader, you have won the first round. Simmilarly, all the way through you must write for yourself, not for the reader. Practice a dead-pan technique, keeping your facts and ideas all on the same level of emphasis with no telltale hints of relative importance or logical sequence. Use long sentences containing many ideas loosely strung together. *And* is the connective most frequently employed in poor writing because it does not indicate cause and effect, nor does it distinguish major ideas from subordinate ones. *Because* seldom appears in poor writing, nor does the semicolon—both are replaced by *and*.

Camouflage transitions in thought. Avoid such connectives as *moreover*, *nevertheless*, *on the other hand*. If unable to resist the temptation to give some signal for a change in thought, use *however*. A poor sentence may well begin with *however* because to the reader, with no idea what comes next, *however* is too vague to be useful. A good sentence begins with the subject or with a phrase that needs emphasis.

The "hidden antecedent" is a common trick of poor writing. Use a pronoun to refer to a noun a long way back, or to one decidedly subordinate in thought or syntax; or the pronoun may refer to something not directly expressed. If you wish to play a little game with the reader, offer him the wrong antecedent as bait; you may be astonished how easy it is to catch the poor fish.

In ignoring the reader avoid parallel constructions which give the thought away too easily. I need not elaborate, for you probably employ inversion frequently. It must have been a naive soul who said, "When the thought is parallel, let the phrases be parallel."

In every technical paper omit a few items that most readers need to know. You had to discover these things the hard way; why make it easy for the reader? Avoid defining symbols; never specify the units in which data are presented. Of course it will be beneath your dignity to give numerical values of constants in formulae. With these omissions, some papers may be too short; lengthen them by explaining things that do not need explaining. In describing tables, give special attention to self-explanatory headings; let the reader hunt for the meaning of P^1r_0.

BE VERBOSE, VAGUE, AND POMPOUS

The cardinal sin of poor writing is to be concise and simple. Avoid being specific; it ties you down. Use plenty of deadwood: include many superfluous words and phrases. Wishful thinking suggests to a writer that verbosity somehow serves as a cloak or even as a mystic halo by which an idea may be glorified. A cloud of words may conceal defects in observation or analysis, either by opacity or by diverting the reader's attention. Introduce abstract nouns at the drop of a hat—even in those *cases* where the ***magnitude*** of the ***motion*** in a downward ***direction*** is inconsiderable. Make frequent use of the words *case, character, condition, former* and *latter, nature, such, very.*

Poor writing, like good football, is strong on razzle-dazzle, weak on information. Adjectives are frequently used to bewilder the reader. It isn't much trouble to make them gaudy or hyperbolic; at least they can be flowery and inexact.

DEADWOOD

Bible: Render to Caesar the things that are Caesar's.

Poor: In the case of Caesar it might well be considered appropriate from a moral or ethical point of view to render to that potentate all of those goods and materials of whatever character or quality which can be shown to have had their original source in any portion of the domain of the latter.

Shakespeare: I am no orator as Brutus is.

Poor: The speaker is not what might be termed an adept in the profession of public speaking, as might be properly stated of Mr. Brutus. (Example from P. W. Swain. *Amer. J. Physics*, **13,** 318, 1945.)

Concise: The dates of several observations are in doubt.

Poor: It should be mentioned that in the case of several observations there is room for considerable doubt concerning the correctness of the dates on which they were made.

Reasonable: Exceptionally rapid changes occur in the spectrum.

Poor: There occur in the spectrum changes which are quite exceptional in respect to the rapidity of their advent.

Reasonable: Formidable difficulties, both mathematical and observational, stand in the way.

Poor: There are formidable difficulties of both a mathematical and an observational nature that stand in the way.

CASE

Reasonable: Two sunspots changed rapidly.

Poor: There are two cases where sunspots changed with considerable rapidity.

Reasonable: Three stars are red.

Poor: In three cases the stars are red in color.

RAZZLE-DAZZLE

Immaculate precision of observation and extremely delicate calculations. . . .

It would prove at once a world imponderable, etherealized. Our actions would grow grandific.

Well for us that the pulsing energy of the great life-giving dynamo in the sky never ceases. Well, too, that we are at a safe distance from the flame-licked whirlpools into which our earth might drop like a pellet of waste fluff shaken into the live coals of a grate fire.

DO NOT REVISE

Write hurriedly, preferably when tired. Have no plan; write down items as they occur to you. The article will thus be spontaneous and poor. Hand in your manuscript the moment it is finished. Rereading a few days later might lead to revision—which seldom, if ever, makes the writing worse. If you submit your manuscript to colleagues (a bad practice), pay no attention to their criticisms or comments. Later resist firmly any editorial suggestions. Be strong and infallible; don't let anyone break down your personality. The critic may be trying to help you or he may have an ulterior motive, but the chance of his causing improvement in your writing is so great that you must be on guard.

FINAL SUGGESTION FOR POOR WRITING

Do not read:

ALLBUTT, CLIFFORD. *Notes on the Composition of Scientific Papers.* Macmillan, 1923.

FLESCH, RUDOLF. *The Art of Plain Talk.* Harper, 1946.

GRAVES AND HODGE. *The Reader Over Your Shoulder.* Macmillan, 1943.

QUILLER-COUCH, ARTHUR. *On the Art of Writing.* [V]. Putnam, 1928.

Suggestions to Authors of Papers Submitted for Publication by the United States Geological Survey. U. S. Gov. Ptg. Off., 1935.

HEART OR HEAD

Tell me how is beauty read
To best advantage? By the heart
Which ahs and sighs and will not part
Or by the analytic head?

Heart, possessive, seeks essentials
Feels reciprocal dependence,
Waives sartorial resplendence,
Gives but cannot be impartial.

Head, aware, through symbol logic
Unifies its world of objects,
Stars and atoms in its projects,
Guides electro-mass panurgic.

Heart when headless pants for breath
Head when heartless conjures death.

JOHN G. SINCLAIR

THE AAAS-GEORGE WESTINGHOUSE SCIENCE WRITING AWARDS FOR 1946

By WILLARD L. VALENTINE
Chairman, Managing Committee

FROM funds provided by the Westinghouse Educational Foundation, A.A.A.S. in 1946 for the first time awarded a $1,000 prize to a newspaper writer for the excellence of his scientific reporting.

The winner of the contest was James Graham Chesnutt, reporter and rewrite man, of the *Call-Bulletin*, San Francisco. The judges also selected two entrants for honorable mention: Herbert A. Shaw, Jr., of the *Dayton Daily News*, and Stephen White, of the *New York Herald Tribune*. The prize and certificates were awarded on December 27 at a luncheon in Boston.

The arrangements for conducting the contest were in the hands of a Managing Committee: James A. Baubie, of Westinghouse Electric Corporation, Pittsburgh; Otis W. Caldwell, General Secretary, A.A.A.S.; Watson Davis, of Science Service, Washington; Morris Meister, President, National Science Teachers Association; F. R. Moulton, Administrative Secretary, A.A.A.S.; G. Edward Pendray, public relations councilor, New York, N. Y.; Robert Potter, of the *American Weekly*; and W. L. Valentine, Editor of *Science*. This committee worked out the details of publicizing the contest, made the rules, and obtained the entries. The success of this work is attested by the fact that there were 137 entries, which were well distributed geographically.

The actual judging was done by a committee selected according to a procedure established by the managing group and included two scientists, two newspaper editors, and two representatives of the public. The scientists were James B. Conant and A. J. Carlson, president and past-president of the A.A.A.S., respectively. The newspaper profession was represented by Wilbur Forrest and W. S. Gilmore, president and past-president of the American Society of Newspaper Editors, respectively. The public was represented by Elbert D. Thomas, U. S. Senator from Utah, who has long been a member of the A.A.A.S., and Sally Butler through her office as President of the National Federation of Business and Professional Women's Clubs. Dr. Meister acted as chairman of the Judging Committee.

The judges met in New York City on December 4 to select the winner after the entries had been screened by Dr. Meister and the writer.

The judges made their selection from eighteen stories, sent to them several days before the meeting in New York. The stories had been uniformly reproduced and coded in such a way that the judges were not aware either of the names of the entrants or of the newspapers, and they could not tell whether they had been printed on the front page or on some other page in the newspaper. Using this method, the judges agreed easily on the top five stories, which they reported immediately when they went into session in New York. These judgments were made wholly independent of each other when the judges were many hundreds of miles apart. The final winners were ultimately selected after discussion of the stories and then unanimously recommended for the awards. Their stories are reprinted on the following pages.

The success of the 1946 contest made certain that it will be continued in succeeding years, and its scope will be enlarged in 1947 to include magazine science writers in addition to newspaper writers. Thus two prizes of $1,000 each will be offered in 1947 from these funds.

THE PRIZE WINNER

JAMES G. CHESNUTT
The Call-Bulletin, San Francisco

IN AN immaculate white laboratory, as spotless as a hospital nursery, a great boon to humanity has been born and is being nurtured through exacting experimentation. It is a specific preventive for the plague, one of mankind's worst scourges through the ages—the dread "Black Death" which takes the various forms of bubonic, pneumonic, and septicemic plague.

The efficacy of this chemical preventive, in animals, has been proven conclusively and dramatically by means of a unique "mouse village," in experiments conducted by one of America's foremost researchers—Dr. Karl F. Meyer, director of the Hooper Foundation for Medical Research of the University of California. And, already, this chemo-prophylaxis-sulfadiazine is being used in China as a preventive of human plague, on Dr. Meyer's recommendation, as a result of the research conducted at the Hooper Foundation. It means that a cheap, easily obtainable, and practicable preventive is available for mass prophylaxis in plague areas, where expensive serums and vaccines could not be used. It means, far beyond that, that a powerful step has been taken toward breaking the time-enduring chain of flea-rodent-human which has saddled mankind with the plague for centuries, with periodic outbreaks of mass mortality like the Great Plague of London, which killed 68,000 persons.

"With chemo-prophylaxis," Dr. Meyer said, "and with the elimination of fleas by use of DDT and other chemicals such as R-1080, we can break the chain. Then we can knock out the rats (for years the only preventive against plague) and the plague is licked for good—obliterated from all closely inhabited areas on the face of the earth." Dr. Meyer, a scientist and not given to extravagant overstatement, does not contend that he has found a "cure" for plague. The real cure lies in successful prevention. Nor is he the first to experiment with the sulfonamides—the "sulfa" family—to combat plague bacilli. But he and his research associates, Albert Lawrence Burroughs and Stuart F. Quan, are the first to demonstrate, with the dramatic "mousetown" experiments, that plague can be controlled and prevented under circumstances approaching those of a human community.

The experiments are complex and many-sided, but the results—so far—startlingly clear.

In the first experiment, conducted about a month ago, 100 mice were put on the east side of "mousetown" and another 100 on the west side. Those on the east side were given plain water to drink. The west-side mice were given sulfadiazine in solution of a concentration equivalent to three grams for a human being in daily consumption. Next, 800 plague-infected fleas, the deadly vectors which spread the disease, were placed in the pens—enough for four fleas per mouse in both pens.

Shortly, plague epidemic was raging in the east pen—the "plain-water" side of town. Mice died at the rate of fifteen to twenty a day. Most of them died from septicemic plague, as the fleas became additionally infected by feeding on the diseased mice, and the remaining water-dieting mice were overwhelmed with plague bacilli. Within nine days, the entire population of the "slum" area, without prophylaxis, was wiped out—to the last mouse. Twenty-five new mice, uninfected, were introduced as "immigrants." All of these were dead within four or five days.

Meanwhile, in the west pen, sulfa-bibbing mice continued to live in normal and

healthy community existence, although bitten by the same infected fleas which were free to commute back and forth between pens. Ten of these sulfa-fed mice died, but Dr. Meyer does not consider this significant, as there was no epidemic and the ninety survivors were healthy. The stricken ten, he feels, probably did not drink enough of the sulfa brew, or received a "fantastic dose" of the bacilli through being bitten repeatedly by doubly and trebly infected fleas.

"The contrast between those two pens was so amazingly striking," he said, "that you know positively that sulfadiazine *is* prophylaxis against plague."

A visit to "mousetown" today, where new experimentation is being carried out in furtherance of last month's findings, is indeed an amazing experience—to use Dr. Meyer's own word—and an unforgettable one. The door to the room in which the experiment is being conducted, a lethal chamber to a careless intruder, is kept locked and the key sequestered behind another door in a closet. Upon entering, one must remove the shoes as though entering a Japanese house and don a heavy pair of wool boot socks. Even the soles of these socks must be wiped on white cloths before crossing the threshold. The floor is surgically white and clean and sprinkled with crystals of DDT. This explains the shoe-removal ceremony.

"We must keep the floor white, so we can see any flea that might escape," Dr. Meyer explains. "Also, we don't want to scatter the DDT too near the pens; we don't want to kill the fleas in there."

In a corner of the room, flanked by two windows, is Mousetown, U. S. A. It is a rectangular box with plate-glass sides, open at the top, about eight feet long by four feet wide and three feet high. Dividing the pen into two equal sections is a partition, open screen mesh for about eight inches from the floor and the rest sheet metal. The floors (or, rather streets) of Mousetown are of soft pine shavings. There are several cardboard "houses," and only a few mice visible.

The absence of population from the scene is explained by Dr. Meyer, sleeves carefully rolled to the elbow for flea surveillance, and using long metal tongs or forceps. "They like to burrow under," he said. "See, here they are. You can see the fleas on that white fellow. That one is quite sick with plague."

In the midst of each pen are two inverted pint flasks, like whisky bottles, the drinking fountain arrangement to furnish plain water to the white mice in the eastern district and to the black mice on the west side.

The black mice, all survivors of the first test, are also on a plain-water diet now. With no protection other than their own immunity—*if* they have built up such immunity from their first experience—they are undergoing a double barrage of plague-infected fleas. "For," Dr. Meyer points out, "the fleas prefer the black mice. They flock over to that side because they have protection by coloration there; they can't be seen so easily as on the white fur. See! Look at that black fellow scratch. . ."

A visitor, and they are very few indeed, is grateful for Dr. Meyer's assurance that the two-foot high fence of slick glass, sealed with phenol and vaseline, prevents the fleas from going "over the hill." They can jump only eight inches high, Dr. Meyer says.

Although plague may be carried by a variety of fleas (notable exception is the common dog flea) Dr. Meyer's experiments have been conducted exclusively with the rat flea, known as *Xenopsylla cheopis*, large colonies of which are carefully raised in a special room of even temperature and humidity.

The white mice on the east side of town present a colorful picture in motion. There are some with daubs of red dye on their fur and others with yellow splotches. The

red-marked mice, Dr. Meyer explained, have been vaccinated with a plague vaccine formed of cultures of "killed" plague bacilli. The yellow-marked mice have been injected with the standard serum, developed at Hooper Foundation during the war and used by our armed forces. This is prepared from the globulin fraction of the blood of immunized rabbits, combined with sulfadiazine.

We want to learn, by this experiment [Dr. Meyer said] whether these black mice, the survivors of the first test, did perhaps contact the infection and cured themselves with sulfadiazine, thereby building up immunity against infection. Also, we want to see what the reaction is of those which have been vaccinated and those injected with serum. See, that one with the red mark (vaccinated) is dying. He's a very sick mouse.

The serum, which was developed by the Hooper Foundation researchers during the war and manufactured on Dr. Meyer's recommendation, is made by injecting rabbits with living, but virulent, plague bacilli. The rabbits thus produce excellent antibodies, far better than those in horse serum, the researcher said.

There is an interesting angle there [Dr. Meyer continued]. If you have a case of bubonic plague and treat it therapeutically with sulfadiazine, you can cure it and save life in about 50 percent of the cases. If you treat it with serum, you'll save, let's say, 40 percent. Now, when you use sulfadiazine and serum combined, you double the cures. That's why the serum is useful in combination treatment. Sulfadiazine alone, used therapeutically, will hold the plague bacilli in check and probably destroy a lot of them, but it liberates poisons and does damage to the tissues. The serum, probably, will neutralize those poisons. So, the solution would seem to be to give sulfadiazine as a prophylaxis, and then more sulfa, plus serum, if the disease is contacted. Just think of it—in a plague area you could put human beings on sulfadiazine of three grams a day and immunize them. About 15 or 20 cents worth per person would do the trick!

The sulfadiazine prophylaxis is now being used in China by Dr. R. Pollitzer, an "old China hand" and plague expert now connected with UNRRA, Dr. Meyer said, upon recommendation of the San Francisco scientist.

The effectiveness of sulfa drugs against the plague bacillus was first shown in 1939 by research by Schutze of Great Britain and was further developed in India by Sokhey, who used sulfathiazole. Sulfadiazine is now used because of its lower toxicity and higher blood level maintained. The case fatality rate in India, Dr. Meyer said, fell from between 60 and 75 percent to 30 percent under sulfathiazole treatment, and to only 20 percent with sulfadiazine.

Plague is a disease which has no given or restricted point of entry into the human system. Bubonic plague may enter the system through a scratch or opening in the skin, contacted by the feces or regurgitation of sick, plague-infested fleas; pneumonic plague, caused by the identical bacillus, but affecting the lungs, may enter by means of oral spray from an infected person. Use of sulfadiazine as prophylaxis, according to Dr. Meyer, would eliminate this source of transmission—both by putting the known contacts on a sulfa diet and by making other persons immune.

"When the mucous membrane of the mouth and nose is covered with this infection-inhibiting drug," he said, "the chemical will keep bacilli from entering by this means."

His contribution to the ageless battle against plague is by no means Dr. Meyer's first distinguished work in the field of scientific research and explorative medicine. Pathologist, bacteriologist, author, and doctor of medicine, he is one of America's most widely known and respected researchers. A native of Basel, Switzerland, and a naturalized American, he studied at the universities of Berlin, Munich, Paris, Zurich, and Bern. After serving in the Transvaal, Africa, and at the University of Pennsylvania, he came to the University of California in 1914, where he was Professor of Bacteriology and Protozoology, joining the

staff of the Hooper Foundation the following year. He became acting director of the foundation in 1921 and has served continuously as director since 1924.

Plague, the disease against which he has been waging laboratory warfare for years, was first mentioned by an earlier physician, Rufus of Ephesus, in the first century, when it was discovered in Egypt and Libya.

It made its entry into Europe in the sixth century, where it colored the course of history by such outbreaks as in London in 1664–65; Vienna in 1679, with 76,000 dead; Prague in 1681, with a death toll of 83,000. The greatest tolls of history, however, were taken in the Orient and in India, where in the plague of 1896–1906 as high as 900,000 victims died yearly.

The *Encyclopaedia Britannica* says regretfully that "unfortunately, there is no plague specific" and adds: "Plague prophylaxis consists in warfare against rats and ground squirrels." The forward stride of science, aided immeasurably by Dr. Karl Friedrich Meyer and his associates of Hooper Foundation—plus several hundred anonymous citizens of Mousetown, U. S. A.—apparently has changed that gloomy outlook.

HONORABLE MENTION

HERBERT A. SHAW, JR.
Dayton Daily News

BASED on information contained in the most up-to-date almanacs, there are four seasons to the year—spring, summer, fall, and winter. But to an estimated 5,000,000 unfortunate residents of these United States there's a fifth season—that of "hay fever." For from on or about August 15 until the first killing frost of autumn hay-fever sufferers seem to breathe nothing but air filled with tiny grains of pollen from ragweed.

True, there are other types of pollen, from both trees and grasses, that bring on the red eyes and running noses associated with hay fever, but in 90 percent of the cases "*Ambrosia elatior*," the botanical term for ragweed, is the chief offender.

Hay-fever symptoms were first described in the early nineteenth century by a doctor in England where there is no ragweed and no fall hay fever. This physician noted that the symptoms were evident only during the haying season in the spring and hence the name "hay fever."

Actually "hay fever" is a misnomer, but so popular has the term become that to change it now would be next to impossible. Doctors prefer the term "pollinosis" since the affliction is definitely caused by plant pollen.

Dr. Bostock, the English physician who first described hay fever's symptoms, erred quite a bit in his diagnosis—as did many of those who tried to prescribe for it in the years that followed. Bostock noticed that his symptoms were more noticeable on bright sunshiny days and came to the conclusion that sunshine was the offender. During the season he barricaded himself in his home, pulled down the shades, and found that he got along quite comfortably. This, it was pointed out years later, was perfectly natural since by closing the house he kept the grass pollen out.

Pollen was not thought to have anything to do with hay fever until years later—1859 to be exact—when another English physician, Charles H. Blackley, came to the conclusion that pollen was the root of all evil.

Blackley, a hay-fever sufferer, explained his pollen theory thusly:

One of his youngsters had gathered a bouquet of grass blossoms—similar to Kentucky blue grass—and placed them in a vase in a room seldom visited by the doctor. A few days later he entered the room, noticed the blossoms, and stopped to examine them. In doing so he struck the bottle and a cloud of pollen rose from the grass blossoms. The incident brought on an attack of hay fever. He then reasoned—and correctly—that pollen was the culprit.

Once pollen was discovered to be the base of the hay-fever affliction any number of "sure cures" was offered.

MOST prominent and popular among the early cures was the change of climate. This still persists. Seashore and mountain resorts early started spirited competition by assuring hay-fever sufferers that a vacation at their site during the season would insure complete freedom from any symptoms.

For those who couldn't afford the privilege of a trip to the seashore or mountains, there were miraculous home cures that included whisky, arsenic, belladonna, candy, cocaine, electricity, horse-radish, ice water baths, opium, quinine, Turkish baths, and tobacco, to mention but a few.

One gentleman, who remains unnamed, had this to say for the whisky treatment: "Whisky, I think, is about the only medicine that gives any decided relief and this is not always sure. It helps to pass away the time and deadens the acuteness of the attack."

A woman in Illinois helpfully came forth with the advice that molasses candy had helped her.

One frustrated gourmet who thought that eating habits definitely had some effect prescribed a diet of raw oysters, chicken, stale bread, and cucumbers.

Reverend Henry Ward Beecher, a long-time hay-fever sufferer, was told by his friend Dr. Oliver Wendell Holmes, that the "gravel" treatment was most heartily recommended.

"Gravel" said Dr. Holmes, "is an effective remedy. It should be taken about eight feet deep."

It might be said of hay-fever sufferers that they brought the whole thing on themselves by becoming civilized. For hay fever is largely an affliction of civilization because ragweed is the product of the cultivated fields.

America, much to the chagrin of the sufferers, is the home of the ragweed. No one loves the plant, bees shun it. Not even plant lice will associate with it.

As mentioned above, the chief offender in the hay-fever line is the "short ragweed," *Ambrosia elatior*. It must have been named by a botanist who did not suffer from hay fever for translated "ambrosia" means "food of the gods."

Second on the offending list is the "great ragweed," *Ambrosia trifidia*. In third place is the Russian thistle, or Russian tumbleweed.

Short ragweed, once known as Roman wormwood, is a slender plant with finely divided grayish-green leaves. Both male and female flowers are born on the same plant. In the North the plants, at maturity, attain a height of only a few inches. However, in the South, aided by a long growing season, they attain heights of from six to eight feet. This type of ragweed is found in almost all parts of the United States.

Big brother to *Ambrosia elatior*—*Ambosia trifidia*—shares a great part of the blame for fall hay fever. Although not as adaptable as its smaller kin, it nevertheless gets around. For the most part it is found in bottom lands of rivers and creeks. Farmers often refer to it as horse-weed. Its average height is at least three times that of short ragweed with upper limits of fifteen feet.

Goldenrod, which for years has borne the brunt of suspicion as chief offender, has

been ruled out by the authorities. Just how the supposition started is not known, but most likely it came about because goldenrod is plentiful and conspicuous in most parts of the country during the ragweed season. If a hay-fever sufferer were to take a deep sniff of a goldenrod plant he would most likely get a violent reaction, possibly because ragweed pollen was present on the plant. The reason is simple. Goldenrod pollen is heavy and sticky and thus cannot float in air. Atmospheric tests prove that goldenrod pollen is almost never found in the air.

The same can be said of the rose with regard to the belief that there is a rose fever early in the summer. Roses do not produce wind-borne pollen. Their pollen is carried entirely by insects. Scientists say that the offense attributed to the rose can probably be laid to grass pollen since grass comes into bloom about the same time.

When father starts in to explain the facts of life in terms of birds, bees, and flowers, the common ragweed will furnish him an excellent example of the latter. Some plants are self-pollinating; that is, the male sperm and female ovary are contained in the same blossom; others are cross-pollinated by insects such as bees, which carry the sperm from one flower to the ovary of another; while the third type—one of which is ragweed—depends upon wind pollination.

It is with the latter that hay-fever sufferers are concerned. To be airborne the pollen must be fine, dry, and powdery. Ragweed fits all three qualifications. Its pollen is microscopic and very powdery. A light breeze will send it soaring through the air in search of a mate. Borne aloft by rising warm currents of air, this pollen dust quickly spreads far and wide.

Just what does this ragweed pollen grain look like? Under a microscope—the only way it can be seen—the grain is an irregular circle with jagged edges.

In substance its chemical composition is as follows:

Alcohol soluble	42.9%
Moisture	5.3
Crude Fiber	12.2
Pentosans	7.3
Ash	5.4
Dextrin	2.1
Protein	24.4

Determination of the amount of pollen in the air, which in turn tells the hay-fever sufferer whether or not he is going to have a bad day, is accomplished by coating microscope slides measuring one inch by three inches with a very thin film of vaseline or some comparable oily substance. These slides are placed in a horizontal position and outdoors over a 24-hour period. In Dayton the count is made over a period from 9 A.M. to 9 P.M.

After exposure the slide is treated with a red dye which is absorbed only by the ragweed pollen. The slide is then placed under the microscope and the red grains counted. The results indicate the number of pollen grains per cubic yard of air. When the count rises above 50, hay-fever sufferers usually get a reaction. This is intensified as the rate climbs upward. In 1944 and 1945 in Dayton the count rose to a high of 1,800 on two occasions. The local average during the season is about 100 grains.

For the benefit of hay-fever sufferers who have looked in vain for a home remedy, it may be comforting to know that for more than a century medical researchers have been working on the project. Most hay-fever sufferers who have not availed themselves of medical advice believe that the mere presence of pollen grains in their nasal passages is responsible for their discomfort. Such is not the case. Hay fever is caused by a reaction in the tissues of the body when pollen poison meets an antagonistic substance in the blood or tissues.

Sensitive people have hay fever when they are exposed to pollen and do not have hay fever when they are not exposed. The effect of the pollen is not local but permeates the whole system of the sufferer. Attacks may be successfully prevented by carefully graduated doses of pollen before the usual season of sneezing. This method, though how it works is not completely understood, produces results.

PRESENT-DAY allergy specialists say that the first sensible way to treat hay fever was attempted in 1900 by a Dr. Curtis. He worked on the theory that injections of the plant that caused the fever into the sufferer would cure. He then prepared a solution of leaves, tops, and pollen of the ragweed. Two years later a Dr. Dunbar carried Curtis' step a little further by extracting protein from the ragweed pollen. He called the extract "Toxin."

Dunbar reasoned that an injection of the toxin should cure fever. To prove his point he gave a huge hypo dose to an assistant. That it produced results is putting it mildly. The assistant recovered, however.

Another popular cure was originated by one Dr. Weichardt, who reasoned that since herb-eating animals were continuously inhaling pollen while eating and suffered no ill effects, they must be immune. From the blood of these animals he prepared a serum called "Graminol," which was injected into suffering hay-fever patients. Though popular, the serum was ineffectual.

Treatment of pollen allergies which in turn bring on hay-fever attacks are now for the greater part in the hands of allergy specialists. Before any type of treatment is started these specialists conduct tests on the subject's skin to determine just what types of pollen bring on the attacks. To do this the allergist prepares solutions of the pollens and injects these under the skin of the arm or back. If the solution after injection causes swelling, the subject is said to be allergic to this type of pollen. Once the type of pollen to which the victim is allergic is discovered, allergists start on a program of immunization which may extend over several hay-fever seasons.

These treatments, consisting of the injection of ever-increasing amounts of pollen extract, usually start several weeks before the expected symptoms appear. Over the season anywhere from ten to thirty injections are made.

Variances of this plan are practiced by allergists. Some give injections through the year; others only during the season. The year-round treatment usually enables the allergist to increase the tolerance of the patient. Any allergist will frankly tell his patient that he cannot promise a cure. Hay-fever patients have been cured before and they are now being cured in ever-increasing numbers. Some persons are cured in a short time; some never.

On the drug side of hay-fever remedy, two new preparations, "benadryl" and "pyribenzamine" developed only recently, have shown some promise. Both drugs are administered by mouth in pill form and are similar in chemical construction. Neither is considered a sure cure, and both have rather unpleasant side effects and reactions in many cases.

Benadryl has been used experimentally by doctors at the Mayo Clinic. Their report on the drug points out that it does not cure hay fever but provides symptomatic relief in most cases treated. Relief of symptoms is often noted within an hour of standard dosage (50 mg.). Some patients are almost completely relieved by two or three doses daily. Side effects of benadryl include such reactions as sleepiness, dizziness, dry mouth, feeling of nervousness, and fatigue.

Pyribenzamine, which is so new it is not yet on the market, has undergone extensive research at the University of Buffalo. Of 313 patients treated there

for allergic rhinitis of all types including seasonal hay fever, three out of every four showed definite improvement. Again physicians emphasize that the drug is not a cure-all and in some cases is not effective at all. It is best used in conjunction with desensitizing injections. Results are not as good when the drug alone is used

Among remedies for hay-fever sufferers which do not entail medication or injections, are home air-conditioning systems and air filters. Both do alleviate suffering by filtering out to some extent the amount of pollen in the air, and by completely changing the air in a room or home at frequent intervals. To receive effective relief through these means, however, the patient is forced to remain indoors for the duration of the pollen season. Once outside he is at once exposed to the brunt of the pollen attack and suffers the consequences.

HONORABLE MENTION

STEPHEN WHITE

New York Herald Tribune

PROBING for the first time in man's history into the cold reaches of interplanetary space, Army scientists have made radar contact with the moon, the Signal Corps announced yesterday. On January 10, a few minutes before noon, a radar pulse was directed at the rising moon from the Evans Signal Laboratory in Belmar, N. J. Two and one-half seconds later a returning pulse was clearly detected on a radar scope. In that time it had made a round trip of 480,000 miles—to the moon's surface and back.

At intervals of a few seconds other pulses were sent from the transmitter, and each time they were followed, two and one-half seconds later, by the telltale pulse on a blue-white cathode-ray tube. A loudspeaker, tied into the system, picked up the echo as a sound—not a very tuneful sound, but an echo from the moon.

There have been previous reports of moon-echoes from radio waves. Sir Robert Watson-Watt, British radar pioneer, announced such work many years ago, and indicated he had gone even beyond the moon. But his experiments could not be verified, and his results are far from certain. The Signal Corps is sure.

The January 10 experiment was not the last. For seven successive days the test was repeated on the rising or on the setting moon, for the antenna could not be pointed high in the sky. There were failures, but time after time the echo came back.

To science, this success has practical values. It is known for the first time that the various layers of the atmosphere—some of them bearing electrical charges—can be penetrated by a radio wave. As the work is pressed forward, refined measurements can be made of the speed of light, the speed of the moon, the distance to the moon. Ultimately, the moon can be mapped.

The Army, too, has a stake in this success. Rocket missiles travel outside the earth's atmosphere, and it was not certain radar could track them. That doubt has been removed. Similarly, long-range jet or rocket missiles can now be radio-controlled from the earth.

On the more fantastic side, the experiment makes it possible to communicate

with the moon. With a little more power, the pulses can be modulated: made to carry signals or voice. Or, when the rocket ship comes to be, the passengers can keep in constant touch with the ground, before they set up housekeeping in the moon and build the first earth-to-satellite radio network.

Project "Diana," as the work was imaginatively named, began at Belmar in August, under the direction of Lieutenant Colonel John H. DeWitt. Colonel DeWitt's interest in moon-tapping was not a new one. In 1940, as chief engineer of Station WSM, Nashville, Tenn., he had tried the experiment on his own. But his equipment could not handle the work, and he failed.

His assistants were E. King Stodola, a graduate of the Cooper Union Institute of Technology and head of the research group at Belmar; Dr. Harold D. Webb, of Franklin, Ind.; Herbert Kaufman, of New Orleans, and Jacob Mofsenson, of New York, a graduate of City College. All but Mr. Mofsenson were radio men before the war; he was new at radio when he joined the Signal Corps and brought to his work the somewhat irrelevant training of a diamond salesman.

It was Dr. Webb and Mr. Kaufman who first detected the moon-echo. They decided not to risk the doubt of their fellows and waited twenty-four hours, when they could repeat the test in the presence of their fellows. The echo came back, and their verity was assured.

There is no doubt that these echoes come from the moon. The presence of the Doppler effect is one proof. This is the effect of motion on wave frequency. If a man throws rubber balls, one a second, at a wall, they will bounce back at the rate of one ball a second. But if the wall is moving toward the man, the rate at which the balls bounce back will be faster. If the wall is moving away, the rate will be slower.

The Doppler effect has a bearing on the moon-echo because, at moonrise, the earth is traveling toward the moon at a rate of 750 miles an hour, and at moonset is traveling away from the moon at the same rate. Further, the moon's orbit is not exactly circular, and hence at all times it is traveling away from, or toward, the earth as a whole.

Therefore, radio waves to the moon do not come back at the same frequency as that at which they are sent. To receive the echo this frequency adjustment must be made. It checks exactly with theoretical calculations.

The Signal Corps announcement was made simultaneously in Washington and at the annual meeting of the Institute of Radio Engineers, in New York. In the New York press conference all those who took part in the original research explained their work to the press.

They were careful to make no Buck Rogers predictions. "We are working now on more powerful sets," Colonel DeWitt said. "But it does not look now as if we will be able to go beyond the moon. These sets," he added, "are powerful enough to send a signal to Mars. But the receiver would have to be on Mars to pick it up. We haven't enough power to get an echo."

Mr. Stodola explained that success could be traced to the tremendous sensitivity of the receiver, which is sixty times as sensitive as the ordinary radar receiver. Operating on an extremely narrow band, it can pick up energy equal to one candlepower at the distance of the moon.

The moon radar differs from conventional radar in several ways, although like all radar it works on the principle of pulse transmission. But where conventional radar uses a pulse of extremely short duration—perhaps twenty-millionths of a second—the moon-set uses a one-half-second pulse. Thus, each pulse carries tremendous energy. Conventional radar sends out thousands of pulses a second. This

set sends out but one pulse in four or five seconds. To prevent the set from being burned out from the tremendous energy it transmitted, water-cooled vacuum tubes are used.

A double-sized conventional antenna is used, with sixty-four dipoles, giving a power gain of 200. A specially constructed "peep-sight" aims the antenna at the moon, and pulses are sent out on a frequency of 111.6 megacycles.

The five men who made the test work were introduced to the press, and later to the Institute of Radio Engineers, by Major General George L. Van Deusen, chief of engineering and technical service, Office of the Chief Signal Officer. To the engineers he described some of the technical details, including the surprising fact that, basically, the set was no different from "the model SCR-271 radar set which was successful in detecting the approach of Japanese planes at Pearl Harbor."

In reaching the moon, the science of radar completes a full circuit. It was this same effort to reach the moon, made by Sir Robert Watson-Watt, that was interrupted by a strange disturbance which occurred at the same time every night. Sir Robert investigated, and learned an important fact.

The disturbance, he discovered, was actually caused by a plane coming into Croydon Airport, near London, on a nightly schedule. Radar was born with that discovery, for if an echo could detect a plane, it was a valuable defense weapon.

In discussing the possible uses of the moon-echo, Colonel DeWitt pointed out that it could be picked up by the proper receiving set anywhere in the hemisphere. He made the fanciful suggestion that if regular transmission between New York and Argentina were to be interrupted, the moon-echo would be available to serve as a channel by which messages could be sent, with a delay of 2.4 seconds. There would be no charge for rerouting, he said.

Book Reviews

DIALECTICAL MATERIALISM

The Outlook of Science. R. L. Worrall. 191 pp. 12/6. Staples Press. London. 1946.

THE popularity of this book, which first appeared in 1933, has led to the publication of a new edition. The subject matter has been brought up to date by the complete rewriting of the chapter on physics and by the addition of certain recent scientific discoveries which are relevant to the thesis of the book.

The problem with which the author is concerned is that of developing a philosophy which will meet the needs of those scientists who are "endeavoring to broaden their outlook and deepen their knowledge beyond the confines of the laboratory technique and mathematical method." The discussion ranges from such general considerations as the meaning of science, religion, and philosophy to such specialized problems as the stuff of the world, space and time, brain and mind, and the laws of nature. The solution, if such it can be called, is the well-known philosophy of dialectical materialism, couched in the usual phraseology ("capitalist civilization," "struggle," "ruling class," "proletariat") and substantiated by many paragraphs of quotations from Marx, Engels, and Lenin. Though lacking in originality, the book is an accurate and interesting presentation of this particular point of view.

The universe, the author argues, is matter in various forms of motion. Matter is self-motivated, and physical change is the sum total of such forms of motion, integrated in an infinite variety of events and processes. Thought is a function of the brain, which is simply matter organized in the course of evolution into a highly complex structure of nerve cells. But although man's material environment determines his activities, consciousness emerges as a "subjective derivative of the objective material processes of the body" and is able, by the use of natural law, to direct environmental forces to its own ends. Thus man may improve himself and society through his own efforts. In perception the mind forms images of an independently existing world, and these images, when brought into progressive agreement with reality, constitute knowledge. Religion is wholly a matter of myth and fancy but is a clever device by which priests, in alliance with the State, preserve the power of the ruling capitalist class.

The neatness of this view gives it a strong appeal. I question, however, whether the author is right in asserting that it is the outlook of the majority of scientists. If this were true he should hardly find it necessary, as he does in this book, to devote so many pages to an elaborate refutation of the "idealisms" of at least seven of the most eminent of recent scientists (Mach, Whitehead, Russell, Eddington, Jeans, Lodge, Haldane). No doubt if one takes some liberties with language and reduces materialism to what he calls its core—that the physical world exists independently of human consciousness—he can find many supporters. In fact he would find universal agreement; the solipsist is a straw man who has been attacked unmercifully but who never has become flesh and blood. However, materialism reduced to these terms is not materialism; it is simply objectivism, a position which is in no sense restricted to the point of view the author is defending.

The essential difficulty of dialectical materialism, I feel, has not been adequately met. How, in view of the fact that nature

is guided by necessary laws and consciousness is a function of the brain, can mind direct environmental forces to its own ends? To answer that mind is aware of natural laws and can use them in the improvement of society is to evade the issue. If mind is guided by law it cannot itself use law, for the use of law implies freedom of choice. The fundamental problem of how matter, which is subject to necessity, can in the course of evolution blossom forth into mind, which is free, remains a mystery. Physics, he says, allows for only two possible explanations of change and development in the universe—blind chance and some supernatural power. Blind chance will surely not do. Supernatural power smells of religion and must be rejected along with all "tendencies" or "principles" "operating through" the forces and activities of nature. Dialectical materialism insists that there is a third possibility. Matter develops into mind because it is *self-motivated*. "From the very nature of its being, matter—in various forms—'does just what it does do.'" Personally, I have some difficulty in seeing how this answer can satisfy the inquiring mind. Like the author, I always feel uncomfortable when explanation is in terms of empty "potencies" and "capacities," but I am even more uneasy when *ignotum per ignotius* is offered as a substitute.

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PSYCHIATRY

The Biology of Schizophrenia. Roy G. Hoskins. 191 pp. $2.75. Norton. New York. 1946.

THIS book represents a somewhat amplified version of the material which constituted the Salmon Memorial Lectures at the Academy of Medicine in New York City in November 1945. These lectures are usually given by psychiatrists, but it is particularly pleasing to have such a vast amount of thought-provoking psychiatric material presented by a biologist who speaks with the authority and experience gained through many years of work as Director of Research at the Worcester (Mass.) State Hospital.

There is no doubt that schizophrenia represents one of the biggest problems in the mental health of the nation today. It is responsible for many thousand mental casualties in young adults each year. Recovery rate is low in comparison to some other types of mental illness, and for these reasons the cost of hospitalization for treatment and care is unusually high.

In the first chapter, the author reviews the various philosophical and scientific concepts concerning the biology of man. Different organization levels, including electronic, atomic, molecular, and especially the level of consciousness, are presented. The distortion seen in the schizophrenic personality is considered at these levels.

In the second chapter, the clinical manifestations of schizophrenia are outlined under the title of The Pattern of Schizophrenia.

In the third chapter, entitled Psychosomatic Aspects of Schizophrenia, the author essentially reviews the results of his own and others' research concerning the physiologic and metabolic changes found in schizophrenia.

In the fourth chapter, the author summarizes all available factual material in A Biological Appraisal of Schizophrenia and suggests other avenues of future research.

Each chapter is clearly, effectively, and completely presented, and the subject matter is thoroughly organized and worked through. To psychiatrists this book will offer additional guidance and stimulation to further research into this baffling problem, but the author had others particularly in mind. He says:

> It is my hope that this book may prove of some aid to non-psychiatrists in obtaining a comprehension of a very baffling subject, to beginners in research

in the field by offering certain suggestions regarding the many problems that are presented, but most of all to intelligent laymen who may be encouraged to exert their influence to the end of setting up a more respectable defense than has ever yet been offered against the menace of schizophrenia.

The nature of the subject matter and the excellence of its presentation should guarantee the consummation of this hope.

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A SCIENTIST'S TOOLS

Scientific Instruments. Herbert J. Cooper, Ed. 304 pp. Illus. $6.00. Chemical Publishing Co. Brooklyn. 1946.

THIS book includes contributions from fifteen authorities in the various lines treated and has been ably edited by one of the contributors, Herbert J. Cooper, B.Sc., A.R.C.Sc.I., A.M.I.E.E. The book is wholly British in its make-up, but the American reader need not be too disturbed by the statement on the first page of Chapter I that "... it can be safely said that British optical glass and British design work are the best in the world."

A work of this kind cannot be expected to be all-inclusive. The editor faces the impossibility of such an achievement when he says in the preface:

> The book is in no sense meant to be an exhaustive treatise on instruments, but it is hoped that it will be valuable to the student and to the research worker, as well as to many people who are using scientific instruments and require a working knowledge of them without going into the details of design.

Every reader will doubtless regret the omission of some instruments in which he is particularly interested, as the reviewer regrets the omission, for example, of such as the planimeter and the photoelectric spectrophotometer, now so widely used in analytical laboratories.

The book is divided into 5 sections, 4 of which deal with optical instruments, measuring instruments, navigational and surveying instruments, and liquid testing. The fifth section is labeled Miscellaneous and deals with acoustical instruments, calculating machines, hardness indicators, and thermionic valves. There are 270 illustrations, practically all of which, especially the line drawings, are of excellent quality. The text is, in general, very well written. The reviewer noted but 11 typographical errors, all of little consequence except perhaps for the misspelling of the name "Langevin" in one place. One figure was slightly incorrect in its drawing, and two others contain faults in labeling. There is a 9-page index, in which only one error was noted in a cursory examination.

The book contains a wealth of material and will undoubtedly prove of value to the type of reader for whom it is intended.

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Comments and Criticisms

MATHEMATICAL ALLUSIONS IN POE

As an admirer of Poe, it was with pleasant anticipation that I turned to page 227 of the September MONTHLY to read the article on "Mathematical Allusions in Poe." Imagine my disappointment on learning that (according to Professor Wylie) my hero was not a mathematician.

For some minutes after a first reading, I sat in humble resignation, wiping away copious tears of disillusionment. Then, with great fortitude, I reread the article more carefully. This second reading led to the happy conclusion that the author had not proved that Poe was not a mathematician. In this connection, permit me to call your attention to a serious slip on the part of Professor Wylie: he has confused Poe's use of what is not today a conventional term with misconception (on Poe's part) of a fundamental concept.

On page 230 of the MONTHLY, Poe is quoted as follows: "The form of the moon's orbit being an ellipse of eccentricity amounting to no less than 0.05484 of the major semi axis of the ellipse itself, and the earth's center being situated in its focus. . . ." Wylie then says: "In this, although the decimal itself is correct, there is a fundamental misconception that cannot be argued away . . . , for the eccentricity of an ellipse is not expressed as a fraction of the major axis of the figure at all. In fact, it is not a length of any description but a dimensionless combination of both the semimajor and semiminor axes a and b, respectively, defined by the expression

$$\text{eccentricity} = \frac{\sqrt{a^2 - b^2}}{a}."$$

Today, it is almost universal practice to define "eccentricity" as a ratio rather than as a length; but there are exceptions. In Baker's *An Introduction to Astronomy*, 1935, we find on page 52: "The eccentricity of the ellipse denotes its degree of flattening. It is represented by the fraction of the major axis that lies between the two foci." This is identical with Poe's use of the term. Again, in *Simon Newcomb's Astronomy For Everybody*, 1932, we find on page 127: "The sun is not in the center of the ellipse but in a focus, which in some cases is displaced from the center by an amount that the eye can readily perceive. This displacement measures the eccentricity of the ellipse . . . " A "displacement" is a length and not a dimensionless number.

So much for present-day usage. Now for a *pièce de résistance* which Poe could hand us if he were alive; it raises the sad fact (mentioned more than once in issues of the MONTHLY) that too many scientists and mathematicians are ignorant of classics pertaining to their own subjects.

Poe's use of the expression "eccentricity" is in exact agreement with Laplace's use of the term. In the celebrated *Mécanique Céleste*, Vol. I, An. VII, we find, beginning at the bottom of page 113: "*Les orbes des planètes sont des ellipses dont le centre du soliel occupe un des foyers; or si dans l'ellipse, on nome* ϖ *l'angle que le grand axe fait avec l'axe des* x; *si, de plus, on fixe au foyer, l'origine des* x, *et que l'on désigne par* a, *le demi-grande axe, et par* e, *le rapport de l'excentricité au demi-grande axe; on aura*

$$r = a.(1-e^2)/[1 + e.\cos.(\text{v}-\varpi)];\ldots"$$

The e in this equation is identical with the dimensionless e which Professor Wylie calls the "eccentricity." But with Laplace e is the ratio of *l'excentricité* to the semimajor axes. Therefore, for him as with Poe, the eccentricity is the actual length from center to focus.

To dispel any doubt as to the significance of the above quotation from Laplace, it may be added that as late as 1835, in his *Exposition du Système du Monde*, page 10, Laplace gives the definition "*la distance du centre a l'un des foyers, est l'excentricité de l'ellipse.*"

If Poe read Laplace's works, he must indeed have been a mathematician of high caliber. However, I do not pretend to have proved that he was. My thesis is that the article in the MONTHLY fails to prove the contrary.—EDWARD C. MOLINA.

HUMANISM

A letter of Mr. E. D. Myers (SM, August 1946) characterizes a letter of mine (SM, April 1946) as "uninformed" and "naive."

It is said to be uninformed because, whereas I contend that "from any objective modern standpoint it must be conceded that the moral content of religions is the only lasting contribution that they have made to man's advancement," A. J. Toynbee's *A Study of History* is claimed to demonstrate that "several religions have furnished the social institutions and organizations within which several civilizations have come into being." Even if it be

a fact that I have underrated the survival value of past contributions of religions to man's advancement, that does not vitiate my conclusion that "however important the myths, fables, and folklore which make up the supernaturalist trappings of religions and encrust their ethical ideals may have seemed in the past, *they have now ceased to have any further social value.*"

But it is by no means certain that I have so underrated any such contributions, because their ephemeral quality is clear: Some of the civilizations founded thereon have already passed from the scene; and the institutions and organizations of others have profoundly changed or have become obsolete under the impact of cataclysmic events and revolutionary knowledge. When Toynbee arrives at the thirteenth and final part of his monumental work—of which so far only five parts (in six volumes) have been published—it may well be that, from the long-range viewpoint of the historian, he will conclude in agreement with the writer that the moral content of religions *is* the only *lasting* contribution they have made to man's advancement.

My letter is characterized as naive because my suggestion that Christians and Jews discard all but the ethical elements of their faiths would, it is asserted, "not only be impossible but would achieve none of the results described" by me.

Impossible? Those most closely in touch with the situation, our ecclesiastics, apparently do not share this opinion as they ceaselessly warn us that the astounding growth of secularism is the peril of our age. Understandably, they dislike secularism because secularism neatly dispenses with their services in that it rejects supernaturalism and considers moral codes as natural human developments rather than as "divinely ordained." Millions, formerly adherents of the two faiths, have already had the good sense to adopt the secular outlook; my suggestion is simply that those still remaining in the faiths do likewise—and, according to the apprehensions of our ecclesiastics, that is what they fear will happen. Such action, which would dispel the age-old religious antagonisms of those professing the two faiths, could, I submit, not fail to have a favorable effect in harmonizing their relationships.

It is charged, furthermore, that I am "deeply committed to current superstitions about 'objective standpoints,' the supremacy of 'modern science,' 'rationalism;' and—perhaps the callowest of all—'humanism' (in the Bahm sense)."

As to "objective standpoints," I note that my critic, oddly enough, is also "deeply committed" to this "current superstition" because he characterizes Toynbee's view, upon which he relies heavily for support, as "*one of the most objective modern standpoints.*"

Apparently, however, I do not share the company of my critic in my commitment to the "current superstitions" about "the supremacy of modern science." Bahm (whose views seem to be even more distasteful than mine to my critic) clearly points out (SM, April 1946) that our traditional faiths are religions based upon "ancient science" and that "the cultural lag in our ecclesiastical systems" results from the fact that many religionists still "insist upon the truth of centuries-old and now-obsolete science." As the "supremacy of modern science" over ancient science is hardly open to challenge, it appears self-evident that religious views based upon modern science are likewise superior to those based upon the primitive concepts of ancient science.

As to the "current superstitions" about "rationalism," "rationalism" has been aptly defined as: "the mental attitude which unreservedly accepts the supremacy of reason and aims at establishing a system of philosophy and ethics verifiable and independent of all arbitrary assumptions or authority"; while "superstition," according to the *Century Dictionary*, is: "An ignorant or irrational fear of that which is unknown or mysterious; especially, such fear of some invisible existence or existences; specifically, religious belief or practice, or both, founded on irrational fear or credulity; excessive or unreasonable religious scruples produced by credulous fears." As "rationalism" is manifestly an antonym rather than a synonym of "superstition," it is difficult to understand how any commitment to "rationalism" can involve "superstition." However that may be, as we are living in the intellectual climate of the twentieth century—rather than in that of ancient or medieval times—I scarcely need offer an apology for basing my views upon reason.

And, finally, and apparently most heinous, is my "commitment" to "humanism" (in the Bahm sense), i.e., "*science*"—the *modern* kind—plus "*values*," alleged to be "the *callowest* of all" the "current superstitions" to which I am committed. I learn from careful investigation that the mature religions (as contrasted with such a "callow" or immature religion as "humanism") abound in such unimpeachably *non*superstitious dramatis personae, histrionic properties, and practices as: gods (single and triple), devils, true gods, false gods, tribal gods, father gods, mother goddesses, son gods, ghost gods, angels in good standing, fallen angels, demons, witches, spare ribs, serpents seductive, serpents from rods, blood sacrifices, circumcisions, chosen peoples, outlanders, arks, covenants, stone tablets, high priests, lowly prophets, pregnant virgins, wise virgins, foolish virgins, saviours, destroyers, saints, heavens, hells (and auxiliary cleansing establishments), water turned to wine, wine turned to blood, bread turned to body, re-

surrections, ascensions, descents, polygamists, celibates, infallible men, fallible women, books verbally inerrant and of plenary inspiration, books canonical, books apocryphal, the worship of gods, the eating of gods, prayers, exorcisms, benedictions, maledictions, aqueous treatment by immersion and aspersion, oily treatment by anointment or inunction, absolutions, indulgences, fastings, feasts, obeisances, genuflections, ikons, relics, stars, crosses, chrismons, medals, beads, amulets, etc., etc., etc.

Of course, it is a question of personal tastes, and my tastes, I concede, are—like my suggestions are said to be—"foolishly simple." Thus, as the above represent maturity in religion, it is easy to understand why *I prefer mine "callow"*!—HAROLD R. RAFTON.

SCIENCE BOOKS FOR THE NONSCIENTIST

Your September issue has a list of "The Ten Most Important Books in the History of Science," by Justus J. Schifferes. I have seen many peculiar lists of "greatest" and "most important" books, but this one is in a class, a very low class, by itself.

Of the nine books actually listed, three have to do with medicine. There is here a far from subtle reflection of the author's prejudices. Worse still, of these same nine books, no fewer than six are by English authors. Under the guiding hand of Mr. Schifferes, the history of science becomes practically the history of England.

Consider a few of the books that Mr. Schifferes introduces as "turning points in the history of science." Bacon's *Novum Organum*, for some mysterious reason, is customarily worshiped as the work of a great mind, of a great systematizer of all knowledge. But in 1620, the publication date Mr. Schifferes gives, there was little material to systematize—and Bacon did not necessarily know all of that little. Chemistry, geology, botany, and other great branches of science were more in embryo than in infancy. Hence, Bacon's work could have little influence on working scientists, who were forced to labor painfully and very often blindly to gather the facts which now figure in the first few pages of our various textbooks. When science had enough material at its disposal for genuine systematization, Bacon's schemes were so far behind the times as to be completely irrelevant.

Malthus' essay on population is another excellent example of a far from excellent choice. Malthus did influence Darwin, but no more than Lyell, whose work on geology was better entitled to a place on the list. (If Mr. Schifferes had substituted Lyell's name, I should have had no complaints that he was an Englishman.) In essence, however, Malthus' magnum opus had little to do with science or the methods of science. It served mainly, not as a "turning point in the history of science," but as an apology for the nineteenth-century gentlemen who hailed war, famine, and disease as benevolent influences in human history. If it turned anything, it was the stomachs of the genuine students of population.

Jenner's book on vaccination and Descartes' *Discours*, on the other hand, are genuine contributions, but they are minor turning points, not major. Jenner's work, for example, does not compare in general scientific importance with that of Pasteur, unrepresented, possibly because he did not influence science by means of a book. Mr. Schifferes might certainly have omitted both these works.

What could he have substituted in their place? I know that some of the greatest contributions to science have not been in the form of books. Still, there were many possibilities. Why not something by Aristotle? It seems to me that he had a slightly greater influence on science than Bacon. So did another ancient Greek known as Euclid. So did Galileo, who also wrote a book. There was Linnaeus, whose name is still dimly recollected by botanists, there were Lagrange and Laplace, there was Liebig's important contribution on agricultural chemistry. There were economists like Petty, Adam Smith, and Ricardo. (This field, where Mr. Schifferes, in its early stages, had an actual right to consider the history of science and the history of England synonymous, he seems to have overlooked entirely.) There was Engels, whose *Anti-Duhring*, unknown to most American scientists and dealing largely with subjects which many of us consider not related to science at all, has had tremendous influence on scientists in Europe. And, in our own times, there once did live a man by the name of Freud, who had a certain influence on psychology. Freud, for the record, did write books.

All these names seem not to have occurred at all to Mr. Schifferes. I grant that some of these books might be difficult to obtain in original editions and to preserve "under glass." Perhaps also a list of ten may be too short to permit an accurate picture of the development of science or may offer too great difficulties of choice. But it was Mr. Schifferes himself who settled on the beautifully round number, "ten." And, in any case, there is no justification whatever for his publishing the sort of list that distorts the history of science.—JOSEPH SAMACHSON.

The Brownstone Tower

COMPARISON of this issue with that of December will disclose minor changes in type face and sizes. These changes were made principally to facilitate production of the SM by our new printer. Copy for this issue had to be submitted to the printer about two months prior to our publication date, which is on the twenty-fourth of each month. It remains to be seen whether an occasional timely article can be published with less delay. Galley proof will be sent by the printer directly to the author, who will send his corrected copy to the editor and his order for reprints to the printer. Each author is entitled to 100 free reprints, but in order to get them he must order them from the printer on the form that he will receive. He may buy as many additional reprints as he pleases. Reprints of articles in a given issue will be made at the time the issue is printed and will be delivered within thirty days after the publication date. Subsequent orders for reprints cannot be accepted by the printer.

We hope that the reprints to be provided gratis will serve as an incentive to those who might write for the SM. In addition, the author of an outstanding article may see his paper appear again in a digest magazine or an anthology. The SM, which holds the copyright, customarily receives a check from the publisher who has been granted permission to reprint the chosen article. The check is then made payable to the author, who is thus both honored and rewarded. Articles chosen for reprinting are likely to be those that attracted attention among the readers of the SM. For example, the essay by R. W. Gerard on "The Biological Basis of Imagination," which excited the admiration of the editors and of many readers, was so chosen. It was a distinguished contribution to Volume 63. But the most popular article we have published in the past three years, as indicated by requests for reprints, was "The Mathematics of Committees, Boards, and Panels," by Bruce S. Old. If the readers had been polled for the purpose of selecting a prize-winning paper, Dr. Old would probably have won by a majority.

Another article selected for reprinting was a contribution to Science on the March by plant pathologist K. Starr Chester, "Victory on the Potato Front." Although we feel that we have published some excellent articles in this section, we must admit that it has not worked out fully as planned. We had hoped, perhaps unreasonably, that each contributing editor would serve as a reporter of advances in his field of science and would supply three significant contributions each year. As some contributing editors have been unable to do so, we feel that Science on the March has not adequately covered the advancing front of science. Therefore, beginning with this issue, the section Science on the March is discontinued. It will be resumed only if arrangements can be made to assure coverage of significant advances in the various fields of pure and applied science. Short articles such as have been published in Science on the March during the past three years are still wanted for publication as principal articles. Perhaps an annual review of progress in each of twelve major fields of science would more nearly spell Science on the March.

F. L. CAMPBELL.